DOCUMENT RESUME

ED 195 391 SE 033 092

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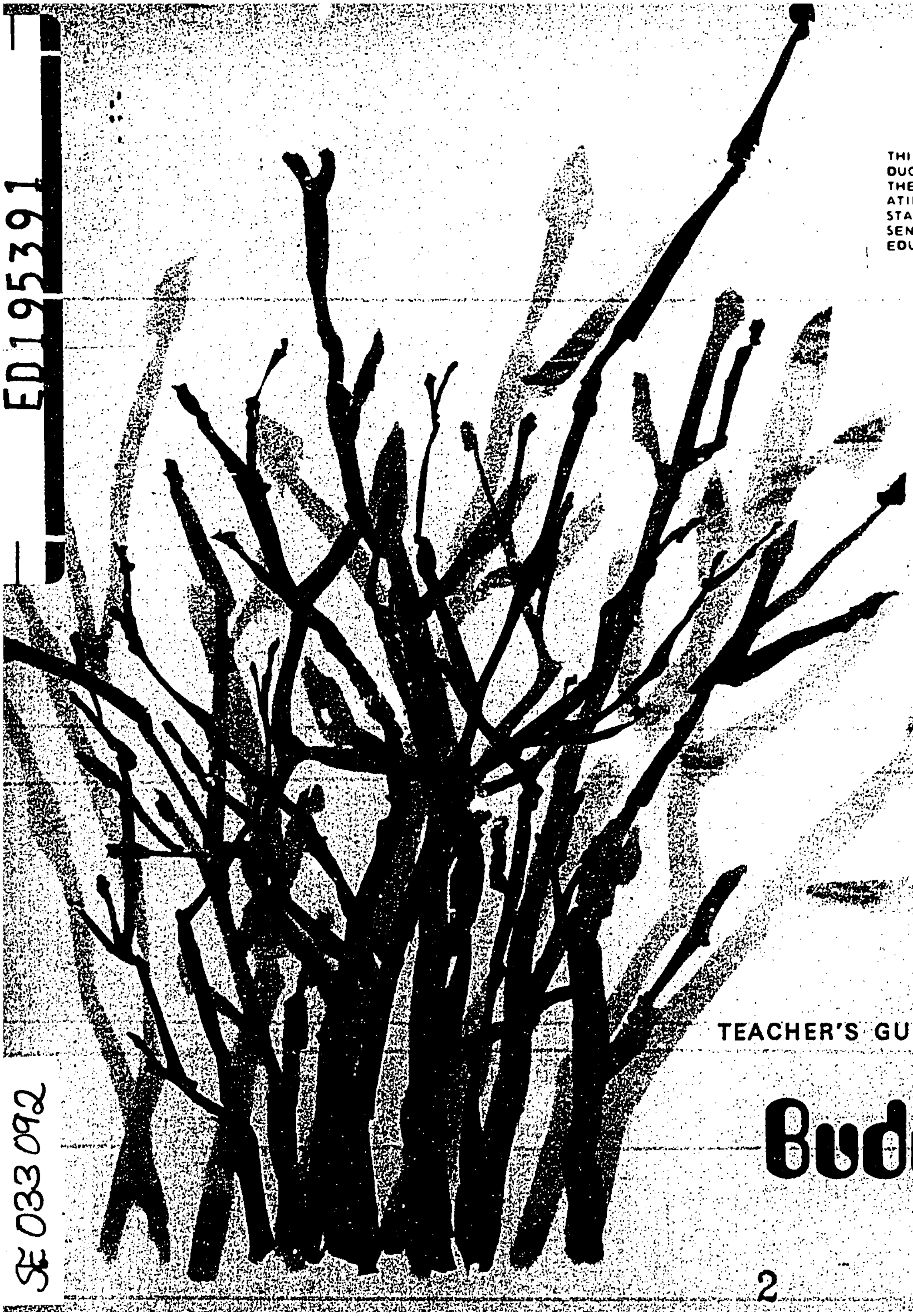
TITLE Teacher's Guide for Budding Twigs. Elementary Science Study.
INSTITUTION Elementary Science Study, Newton, Mass.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE 70
NOTE 50p.: Photographs may not reproduce well.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Biology: *Botany: Elementary Education: *Elementary School Science: Grade 4: Grade 5; *Science Activities: Science Course Improvement Projects: Science Curriculum: Science Education: *Teaching Guides: *Trees: *Units of Study
IDENTIFIERS Shrubs

ABSTRACT

This teaching guide supplements a science unit concerned with bud maturation recommended for use in fourth- and fifth-grade classrooms. The first section describes possible activities for children to explore, such as field study, collections, dissecting, and experiments. The second section offers a few brief suggestions for teaching the unit. The third section outlines methods for obtaining and preserving twigs. (CS)



TEACHER'S GUIDE FOR

Budding Twigs

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Teacher's Guide for

Budding Twigs

Elementary Science Study

Webster Division, McGraw-Hill Book Company

New York • St. Louis • San Francisco • Dallas • Dusseldorf • London • Mexico • Panama • Sydney • Toronto

Preface

The Elementary Scie[illegible] Study is one of many curriculum [illegible] [illegible]ment programs in the field[illegible], so-cial studies, and ma[illegible] under preparation at Educat[illegible] [illegible]ment Center, Inc. EDC (a p[illegible] [illegible]fit organization, incorporati[illegible] [illegible]ti-tute for Educational Innov[illegible] [illegible]d Educational Services Incorpo[illegible]e-gan in 1958 to develop new ideas [illegible]d methods for improving the content and process of education.

ESS has been supported primarily by grants from the National [illegible]ience Foundation. Development of [illegible]erials for teaching science from kindergarten through eighth grade started on a small scale in 1960. The work of the project has since involved more than a hundred educators in the conception and design of its units of study. Among the staff have been scientists, engineers, mathematicians, and teachers experienced in working with students of all ages, from kindergarten through college.

Equipment, films, and printed materials are produced with the help of staff specialists, as well as of the film and photography studios, the design laboratory, and the production shops of EDC. At every stage of development, ideas and materials are taken into actual classrooms, where children help shape the form and content of each unit before it is released to schools everywhere.

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Acknowledgments

BUDDING TWIGS was developed in classrooms in Newton, Needham, Watertown, and Weston, Massachusetts.

Much of the laboratory research on twig development was done by Frederick A. Gornall, who tried the unit out in a fifth grade classroom at the Mason-Rice School, Newton, Massachusetts, in the spring of 1966. A working paper based on developmental teaching in the spring of 1967 was trial taught by teachers in different regions of the country in 1968. This revision is based on reports from that group and on further developmental assistance from David Alexander, Beth Barth, Merle Bruno, Mary S. Gillmor, Robert Stinson, Virginia Strong, and Rosly Walter of the ESS staff.

Merle Bruno deserves special thanks for the long hours she spent observing my classes, offering constructive criticism and technical advice throughout the many phases of the unit's development. I am grateful, also, for the physical and moral support she and her dog, Scylla, gave on numerous collecting trips.

Rhoda Goodell patiently cared for and stored the hundreds of twigs used during the three years of development.

The photographs were taken by Joan Hamblin, George Cope, and Major Morris of the EDC photo studio. The pictures on pages 6, 17, and 39 are by Eric "Ricky" Wilkins. That on page 7 is by Merle Bruno. The drawings on pages 33 to 37 and on the classroom charts are by Sylvia Gornall. All other illustrations are by children.

Adeline Naiman edited the manuscript, and design suggestions were made by Nancy L. Weston.

Rose Lea Crowley

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Introduction

. . . As Frodo prepared to follow him, he laid his hand upon the tree beside the ladder: never before had he been so suddenly and so keenly aware of the feel and texture of a tree's skin and of the life within it. He felt a delight in wood and the touch of it, neither as forester nor as carpenter; it was the delight of the living tree itself.

—J. R. Tolkien
*The Fellowship of the Ring**

** Boston: Houghton Mifflin Company, 1967, (2nd edition), Vol. I, p. 366. Reprinted by permission of the publisher.*

We all know what a tree is like. Or do we? Are the branches really "bare" when deciduous trees drop their leaves? What makes us aware of spring's arrival—the massive blossoms of the magnolia or the diminutive flowers of the maple? Do children ever see the delicate flowers that precede the acorns, pinecones, or maple keys they enjoy collecting?

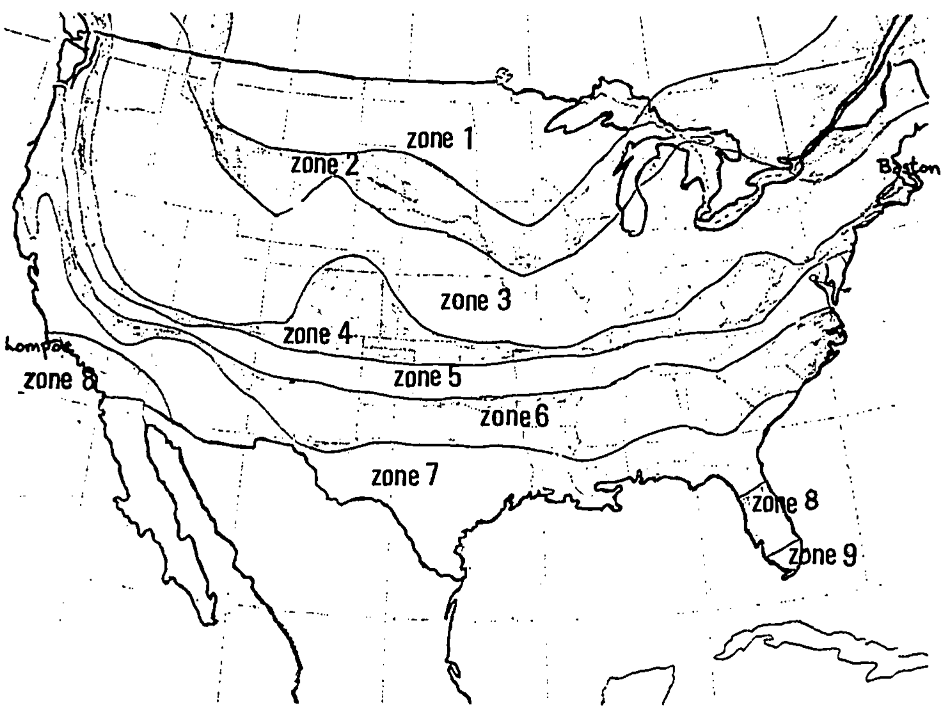
BUDDING TWIGS gives children an opportunity to examine, in the classroom, the structure of twigs and the development of buds forced into bloom ahead of season. Through observation and dissection, children become aware of the varieties and complexities of plant structure. They observe the development of buds outdoors. They are encouraged to collect twigs and try to predict what the buds will become. As the study progresses, they design experiments to answer their own questions.

The "bare" winter twigs focus the children's attention on the buds, their covering, position, number, and arrangement on the twig; the bark, its variations of color, texture, and openings; and other external structural features, such as leaf scars, thorns, hairs, and spikes. The development of the buds reveals growth characteristics, the placement of leaves in relation to flowers, the sequence of leaf or flower appearance, and the different structures on one specimen.

When children dissect buds, they discover the diversity in the internal structures of both bud and stem. Most important, children are given an opportunity to examine a small part of their world and to learn how to use their eyes, fingers, and minds in doing so.

Grade Placement

BUDDING TWIGS has been taught in grades two through eight. High school biology students have also worked successfully with the materials on individual projects. The unit is especially recommended for use in fourth and fifth grade classrooms as a whole-class or small-group exploration.



Scheduling

BUDDING TWIGS is planned as a late-winter and early-spring unit. Since it is concerned with bud maturation, the time when you can begin the study will be different in various parts of the country. For example, in the area west and north of Boston, Massachusetts (Zone 3 on the following map), buds begin swelling in late February, and classes can begin shortly thereafter. In Lompoc, California (Zone 8), a teacher can begin the unit in January. Additional local factors—especially proximity to the sea, elevation above sea level, and yearly rainfall—will affect the date of tree budding. Any county, state, or federal agricultural agency should be able to supply specific information about the budding schedule of trees and shrubs in your locality.

Using the *Guide*

The study should take from six to eight weeks. If interest persists, however, it can continue over extended periods.

In developmental classes, meetings were held on Monday, Wednesday, and Friday, or on Tuesday and Thursday for forty-five minutes to an hour. This spacing of the meetings allowed the twigs growing time between periods. At the beginning of the unit, the length of the period was generally adhered to. As the study progressed, time schedules were adjusted to the requirements imposed by the activities. If your schedule is flexible and bud development warrants, you may want to meet for a shorter period every school day.

BUDDING TWIGS has been taught in both self-contained and specialized classrooms. In self-contained classrooms, where the children were free to go to the twigs throughout the day, more informal and numerous observations and more experimentation took place. In specialized rooms, children often missed the subtle changes that took place between science periods. In such situations, you may have to plan an additional plant-tending time or arrange for the children to carry their twigs back to their homerooms.

This *Guide* is intended to help you teach BUDDING TWIGS the first time. It suggests a beginning and several points of departure for further investigations. You will find, as you read it, that being familiar with all the suggested activities will prove more valuable than trying to establish a sequence to follow.

Throughout the unit, it will be difficult to separate the examination of bud and twig structure by dissection from the experiments on plant growth and development. They will undoubtedly be done concurrently and should not be handled separately as they are, of necessity, in this *Guide*. If you have the good fortune to be located in a rural setting or have access to a public park, field study should also be a large part of your unit.

The first section, "Activities," describes the possible activities and avenues of exploration. This draws on the experiences of classes that have worked with the unit.

Section two, "Some Teaching Suggestions," offers a few brief suggestions that may help you teach this unit.

The third section, "Collecting and Caring for Twigs," tells you how to obtain the twigs themselves, and how to preserve them until you are ready to use them in the classroom.

A brief section on reference material appears at the end of the *Guide*. It lists reference books you may find useful. Since the main purpose of this unit is not the identification of particular trees or shrubs, but rather the children's observation of what *happens* to their twigs, you may choose to teach without reference materials and to share with your students the excitement of watching twigs develop.

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Materials

With the exception of a collection of twigs (see page 29 and following), all the materials you will need to study BUDDING TWIGS can be found in hardware or variety stoes, at home, or in school. The children can help assemble dissection scopes and plant presses from simple materials. To teach this unit, you will need the following:

For each child:

twigs (at least 10)

half-gallon milk carton

hand lens (ES0706)*

tweezers (ES0707)*

T-pins (at least one)

marking tags

wire strippers or pruning shears (ES1016)*

cardboard tray (9" x 12")

* *These numbers refer to the* McGraw-Hill Science Materials Catalog.

For the class:

large pail or wastebasket

tree paint or spray paint

plastic garbage-disposal bags

Sauer's food coloring† or any "permanent" ink

small saw (keyhole or pruning)

file (8", half-round, second-cut)

sandpaper (assorted grain sizes)

paper, pencils, crayons, notebooks

plant press (see page 28)

† *Available from bakery suppliers.*

Plasticized half-gallon milk cartons make good twig containers. The tops may be cut off, if you prefer. Every child will need one at the outset, but plan on at least an additional one for each. You will need a few spare cartons and extra twigs for emergencies.

Metal containers can kill twigs. Glass fruit jars are fine but breakable.

The tweezers and T-pins are used as dissecting tools.

The 9" x 12" cardboard meat trays are used to dissect buds on and to make cleaning up easier. If these or other trays are not available, you might substitute flat boxes.

Small marking tags, such as Dennison No. 7 string tags, can be attached to the twigs.

You will need something to cut branches with. Wire strippers limit the diameter of the branch that a child can cut (approximately 5/8") and thus prevent unnecessary damage to the tree. They also keep the length of the branch within manageable limits. You will need a small saw for larger branches.

The files and sandpaper are used to polish cross-sectional cuts of wood in order to make the annual growth rings more distinct.

Plastic garbage-disposal bags are used for twig storage and rubbish.

Activities

Field Study

The best way to conduct this unit is as an outdoor study of the trees on or near the school grounds or in a wooded area within walking distance from the school. This gives the class an opportunity to study trees and shrubs in their natural environment. By making their own cuttings, the children develop a better sense of the relationship of the twig to the total structure of a tree. After working with twigs for a while, a fifth grade boy excitedly announced to his teacher that the tree in his own backyard was "covered with twigs" that he was also going to watch.

Generally, on the first trip, twigs have been brought back to the classroom for detailed observation and experimentation. On subsequent collecting trips, the children, armed with sketching materials, have made drawings of these trees before and as they developed. Some children have selected one tree to study in depth, while others have decided to do comparison studies of the trees in the area. The development of the buds in their natural habitat has meant more to the children after they have studied the early development of buds in the classroom.

One class who made their first cuttings on a Friday were thrilled to find that the buds had started to open by Monday morning. Later that day, when they went outdoors to check their trees, they were surprised to find that the tree buds had not developed. This led to a discussion of the factors that might have caused the difference. The children noted also that the degree of development was dependent on the species of tree they had chosen. This led some of the children to experiment with ways to hasten the development of slow-budding species in the classroom.

If you are fortunate enough to have a tree close to your classroom window, try pulling a branch in through the window, where the warmth of the

room will force the development of the buds. Later, as the rest of the tree develops naturally, the opportunity to watch the buds unfold a second time often reveals changes overlooked and ignored during earlier observations.

Field study presents many possibilities for projects. Mapping an area of trees is interesting. The class might plot the area surrounding the school, while individual children might choose to concentrate on their yard or street trees. A tree census can be undertaken and a chronological list of blooming dates noted. One class produced an album of drawings showing bud development of the trees in their schoolyard. They made a chart of the trees' blooming dates which the teacher planned to keep and add to each year. She hoped, in time, to be able to predict even when individual trees would bloom. (See "Budding Sequence Chart," page 41.)

If you cannot arrange field trips, a good way to begin this unit is to distribute twigs that you have collected to the students and ask, "Are they alive?"

While examining their twigs, the children usually discuss what "alive" means to them. This discussion may tell you what previous experiences your class has had with plant life.

"They are cut off, and that makes them dead."
"My mother cuts pieces off plants to grow other plants."
"Maybe it depends on what they are cut from—these are trees."
"Pussy willows grow roots in water."
"They're not dead yet, but when they dry out they will be."
"It will die without food from the roots."

The question is a difficult one for children to resolve in relation to their twigs, but the immediate challenge of how to answer it will turn their discussion to a description of experiments they might design to test their theories of plant life and growth.*

"We could stick the twigs in water and wait to see what happens."
"I would like to plant mine in sand and give it fertilizer."

Encourage the children to try the experiments they describe.

* *See the Elementary Science Study units* THE LIFE OF BEANS AND PEAS *and* STARTINC FROM SEEDS *available from Webster Divisic :, McGraw-Hill Book Company, Manchestei Road, Manchester, Missouri 63011.*

Children's Collections

Some of the children will want to bring in cuttings of their own. (Some may have done this already.) To encourage this, allow each child to take home a pair of cutters. You might suggest that the collectors keep track of where they found the cuttings.†

Plan time for the children to discuss and display their collections. They will often volunteer to provide twigs for the rest of the class. In one classroom, after a variety of cuttings appeared, the teacher asked each child to snip a two-inch piece from his twigs. These, when spread on a tray, dramatically revealed the great variations in bark coloration and twig structure that are commonly found. This surprise precipitated an exciting discussion on twig bark.

A collection like this can be the basis for games: (1) find your twig, and (2) sort the twigs into groups. A class collection can also be mounted for display.

The children's cuttings, chosen at random, will probably represent a variety of trees and bushes, and each may develop at a different rate. If a particularly quick-budding and interesting specimen appears, you may be

† *See page 30—trespass laws.*

able to make a field trip to observe the tree and pick additional samples—provided you have the permission of the tree's owner, and the tree is within walking distance of the school.

Before the end of each period, distribute the marking tags for the new twigs. They can be marked with numbers or letters or in some other way. The class may decide to mark the twigs you issue one way and the cuttings they collect another way.

One teacher decided not to have the children mark their twigs. In order to discuss a particular twig, the children had to give more specific descriptions to make themselves understood.

Fred: "My small buds are turning into little red flowers."
Annette: "Mine are turning into yellow things."
Nappy: "They're talking about different twigs. Her twig has brown bark on it, and his is gray."

Dissecting

The word "dissect" has a magical effect on many children. It seems to imply that "real" science is being done, and it coincides with their picture of what scientists do. It may relate to the child's belief that many of the answers to questions they pose seem to be within the objects they are investigating. Even the most timid child responds eagerly to the dissection of twigs. This scientific examination of buds and twigs provides opportunities for making additional observations, develops manipulative skills, and encourages record-keeping.*

For the first few classes, try to choose twigs with large or numerous buds. Trial teachers used twigs with bud clusters, such as maple, or with large buds, such as magnolia. Give everyone a twig with a bud to examine, and ask the children to describe what they see.

What could you do to learn more about the twig?
Could you learn more by dissecting the twig?
What will happen if you put the dissected twigs in water?

Usually, the children begin to strip and dissect their specimens without prompting. Buds are torn apart ruthlessly, and young scientists report to one another what they have found. While this is happening, you can distribute notebooks or paper and suggest that some children may wish to make notes or draw what they see. Try not to force the issue. Record-keeping evolves naturally when it is not required by the teacher, and it is usually of greater value to the child than forced note-taking.

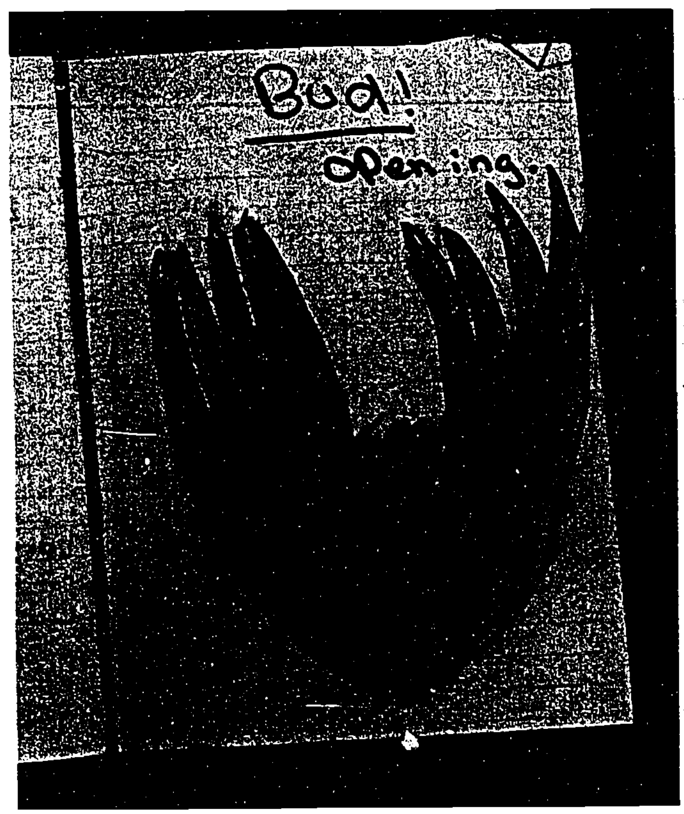
Have a reserve supply of cuttings on hand, since sometimes a child will be overexuberant and dissect his specimen until he has nothing to watch develop. Initially, you may wish to distribute to each child at least two twigs of the same species—a smaller section to dissect and a large twig for experiments. It may be wise to tell the class that they should each keep one of the twigs to see what happens to it. Remember, the children are learning to dissect as well as to observe, and they should have an adequate supply of twigs to provide for both kinds of investigation. As their skill improves, the children will destroy fewer buds and will make more precise dissections.

See page 26, "A Homemade Dissecting Scope."

During these first classes, you can promote discussion, as you introduce a new twig, by asking what differences the children find. Dissection will continue, however, concurrent with whatever chalkboard drawing or discussion takes place. The children usually dispute first statements and make repeated dissections to refute their classmates' testimony or to verify their own findings.

Bud Development

If bud development has occurred in the interim between class periods, give the children time to discuss what has happened before you introduce a new type of twig or a new activity.



Has the bud grown larger?
If the bud has grown, is the twig alive?
Has a crack appeared in the bud covering?
Have small leaves started to unfold?
Are there other interesting structures that have appeared?

This kind of discussion often leads to more drawings and dissection. Additional or longer branches are necessary at times, especially early in the study. Also, some children will be reluctant to dissect twigs if they feel that the supply is limited.

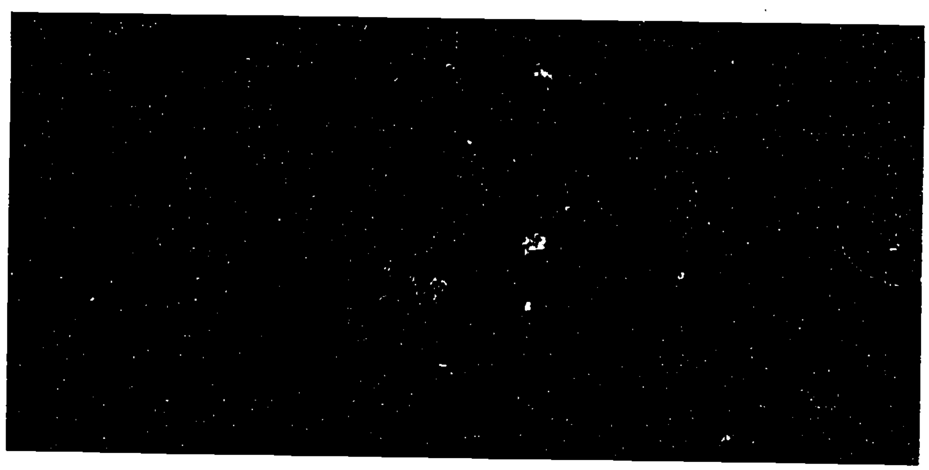
When introducing a new specimen, ask if the class has had this kind of twig to examine before. Can the children explain why they have arrived at their conclusion? Having to do this makes them observe more carefully the external features that distinguish one type of twig from another. Do not prolong these discussions, for the children will be eager to get on to the dissection of the new buds.

After the children have examined four or five different kinds of twigs, distribute to each a small twig that matches one of the specimens they all have in their containers. Can the children pair the twigs with those in their containers? Here again, a child must examine and compare the external structures to reach his conclusion.

Rings and Things

The internal structure of twigs is another good subject to investigate. For this, short twig sections are used. In one class, the children came to dissect the stems when they were matching a twig with the specimens in their containers. One child noted that the cross-sectional cut of the stem was also a useful clue in twig matching. This led to the dissection and analysis of stem layers.

Are the insides of the stem similar in all twigs?
What are the similarities?
What are the differences?
Does the inside structure affect how long the twig stays "alive"?



More About Rings

If the question of internal structure does not arise naturally, you can introduce it after a discussion of external features has taken place. You can ask if the children think the inside of a twig is the same throughout the length of the twig and, subsequently, if other stems are structurally similar. Once again, additional stem sections are necessary. As before, dissections will be crude initially, opinions will be varied, and statements will be disputed. You will notice, however, that discussions become shorter as statements become more specific and conclusive.

During trial classes, two interesting stem-dissecting approaches and groups emerged. The "breakers" launched their attack with twig cutters, split the stems, and investigated from within. The "peelers" used fingernails and tweezers to strip each layer from the stem and worked toward the center.

During a disagreement as to the number of layers in a stem, a child explained that this difference could be attributed to a difference in the ages of the twigs. He went on to explain that somehow tree ages could be determined by their rings. This is true, of course, but it is not as easy to see in a twig, which may be only a year old. It did, however, present a point of departure for the next activities.

Many children seem to know that the age of a tree can be told by counting the rings in cross-sectional pieces of the trunk. The following activities will lead them to examine this more closely.

The following questions can start children thinking about the age of a tree and its annual growth rate, the variation of ages among parts of a tree, and the differences between animal and plant growth.

Are your fingers as old as your toes?

A good question to follow later is—

Are all parts of a tree the same age?

This suggests an activity for which you will need a saw and a large limb with its smaller side branches or, if you are more fortunate, a small complete uprooted tree. For your purpose, the tree or limb need not be alive and growing, but its bark should be firm, and it should have branches of different thicknesses. Have the class make a quick sketch of the complete limb before you cut it. With a wire cutter or pruning shears, remove the end twigs. If some of the buds look healthy, save a few so that you can watch their development. As you cut and distribute the sections, suggest that each child mark on his drawing the section of the limb from which his cutting came. The children will want to examine and compare these pieces before they begin to dissect them.

Are all the external structures similar?

Is the bark the same color on all sections?

How do cut surfaces of the cross sections differ?

You may wish to show the children the limb at the end of one class period and have them sketch it. The limb could then be sawed at any time before the next meeting, perhaps with the help of someone in the school shop.

Some children may become interested, at this time, in making a collection of cross sections from different parts of the same tree or from different trees. By using first a wood file to smooth a rough cut and then sandpaper to finish it, they can make handsome polished pieces.

Tree Puzzles

Another activity that has stimulated the examination of both internal and external characteristics of a tree's structure is the making of tree puzzles. These are made by sawing large branches into three-inch sections. In order to realign the pieces of the limb, children must use both bark and ring formations as clues. Additional clues are often provided by the visible effects of insect borers, foreign bodies, or diseases the tree has managed to overcome.

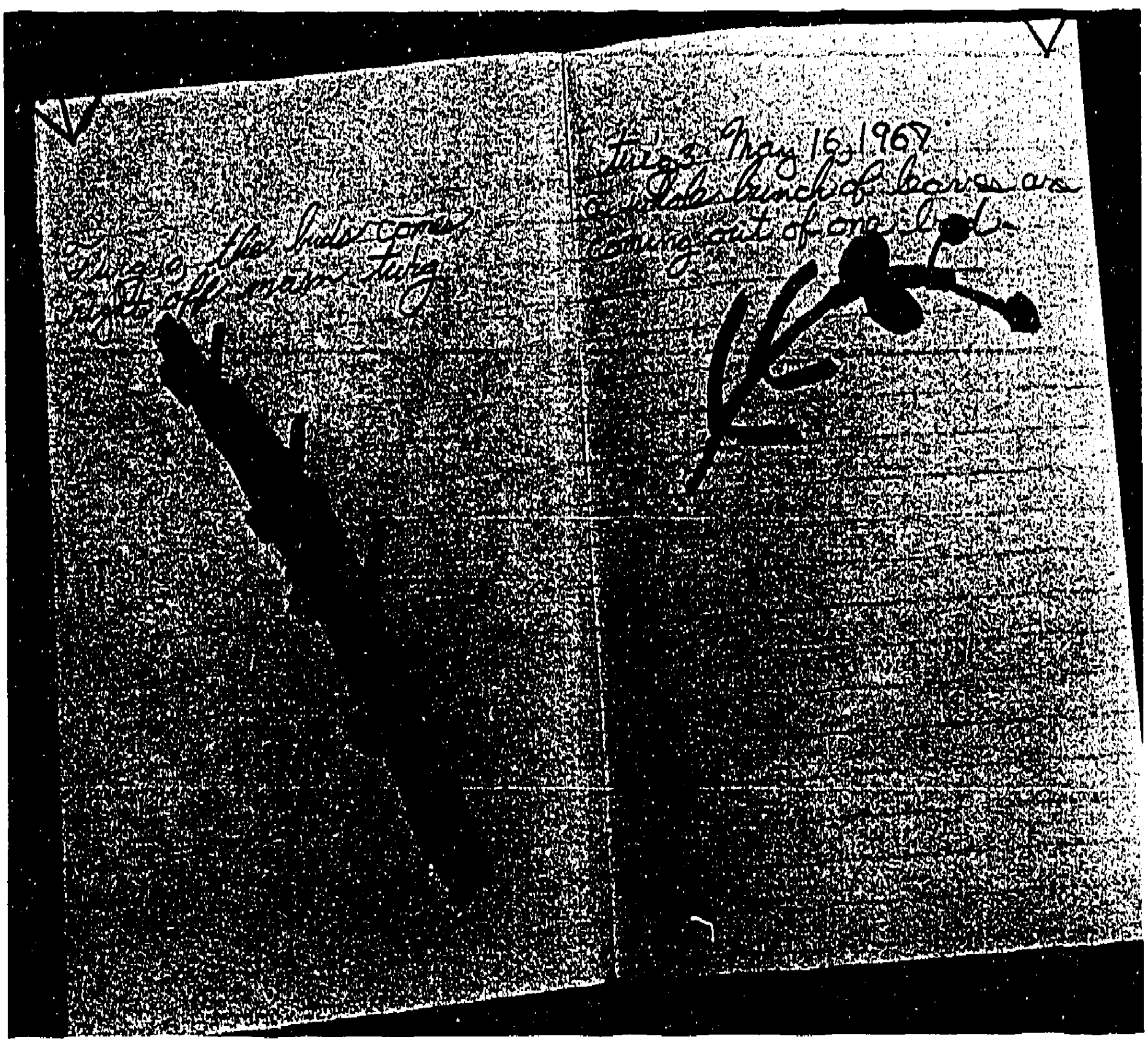
Most tree limbs make challenging puzzles. One elaborate puzzle was made from an eight-foot section of a sycamore branch that made three right-angle turns. A dull-looking four-foot piece of maple limb, when cut, proved to be riddled with interesting insect tunnels.

If you decide to use tree puzzles, allow the limb time to dry in a warm place for a few weeks before you have it sawed. An electric band saw gives you the smoothest sections and does the job in minutes. You may want to experiment with different cutting angles on some puzzles. Straight cuts produce more challenging "experts' puzzles." Some of your pupils may want to make their own puzzles in the classroom. Hand tools do not, however, produce as attractive a product.

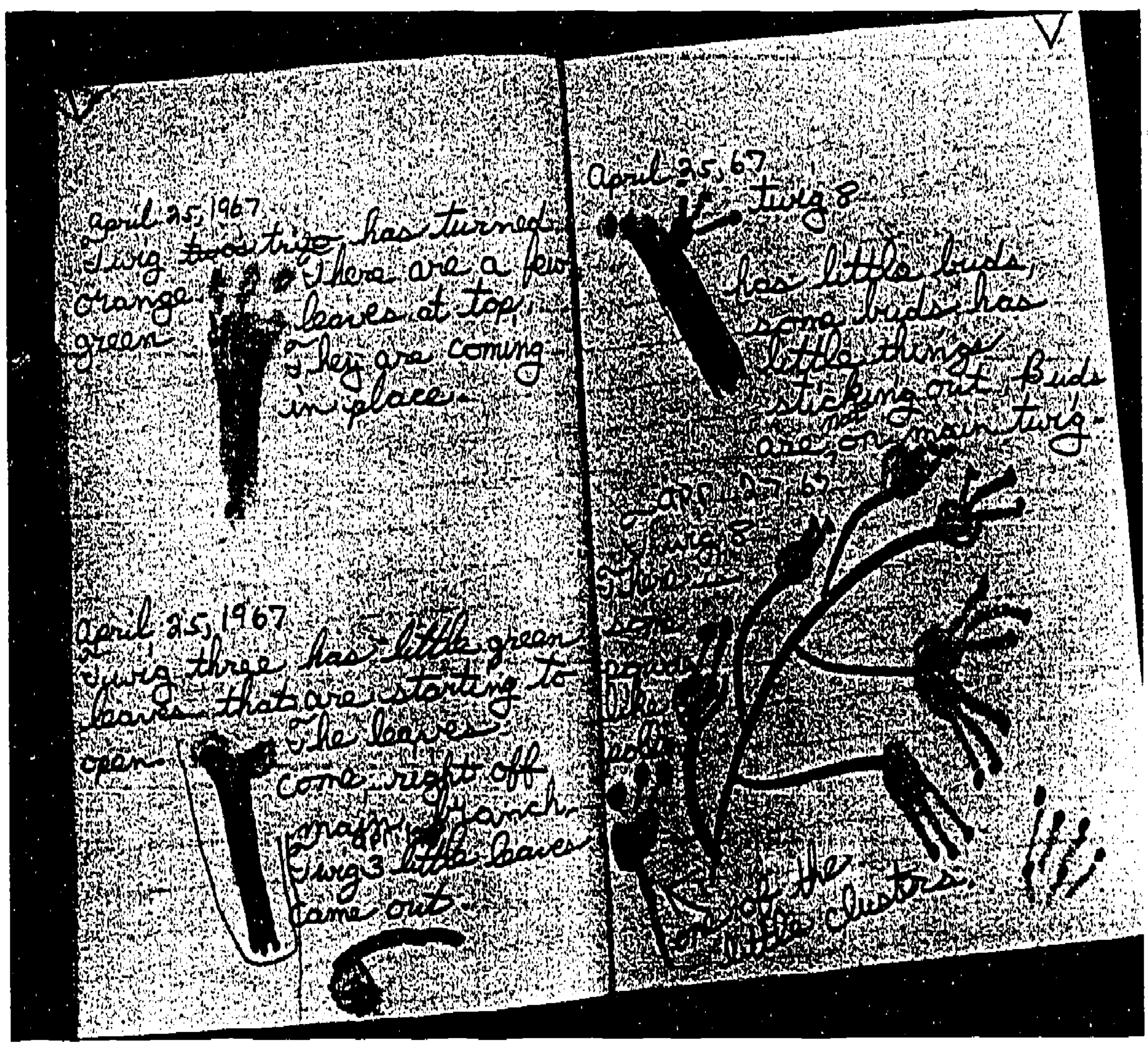
A school principal made an imaginative puzzle from a finished piece of lumber that had a distinctive and interesting grain. Children will also make mini-puzzles from twigs and exchange them with classmates.

Some of the Things Children Do

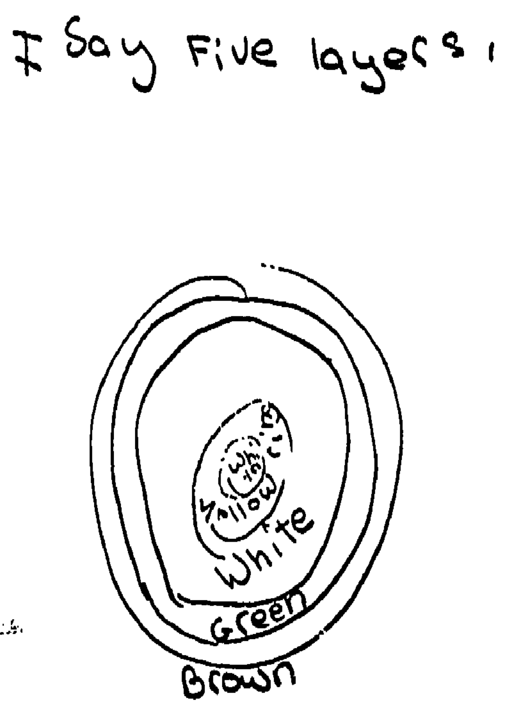
*They observe
different growth patterns.*



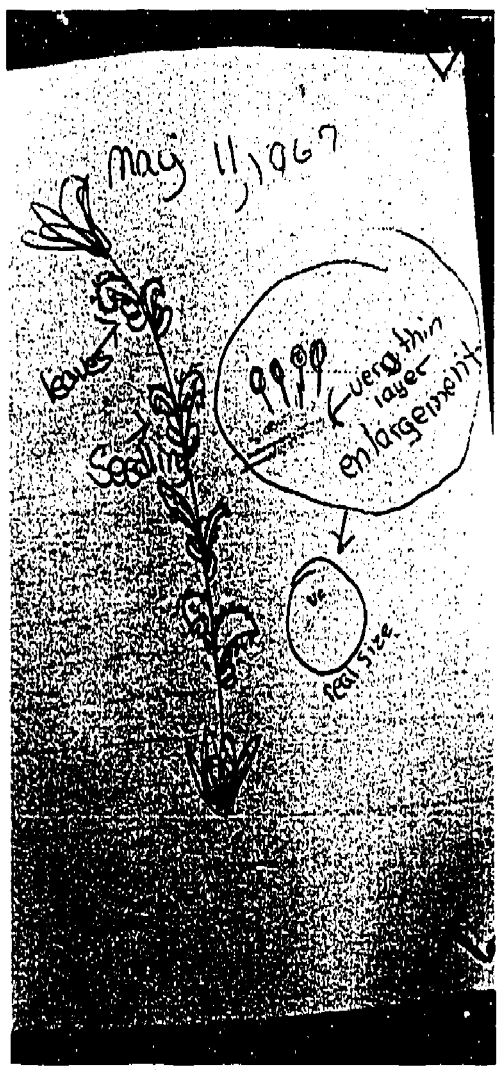
They express the same botanical fact in a variety of ways.

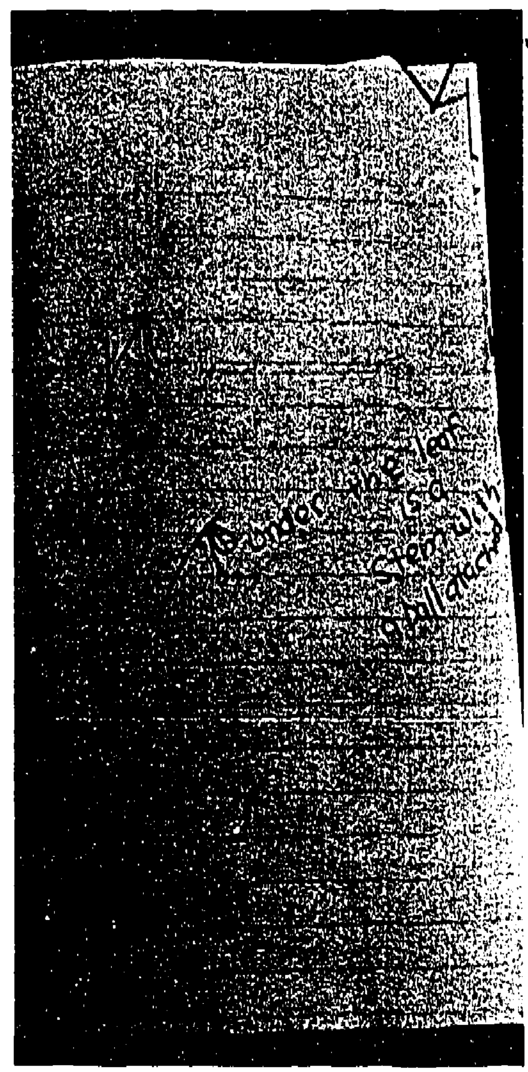


They make positive statements based on their *information.*



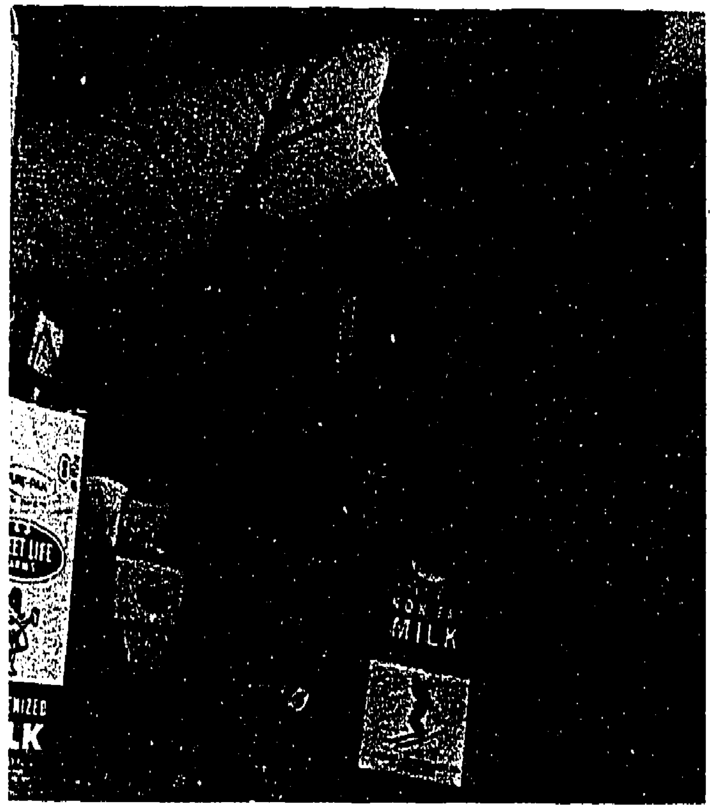
They observe structural differences.





Questions and Experiments

As dissection and observation progress, questions will arise naturally that will lead the class to experimentation. Most branches and twigs are rugged and can stand repeated handling without apparent ill effects. If the specimen is from a particularly fast-growing kind of tree or bush, experiments can be repeated within a short space of time. During trial classes, some questions were posed by individual children, who then carried out their own experiments individually. Other questions arose out of classroom discussions, and, to answer these, experiments were conducted by all the children.



The first questions raised will usually refer to conditions for plant growth. Remember, when a child is searching for "the best place to put my twigs," he is, in effect, conducting an experiment.

Will it make a difference where we place the containers?

In one classroom, the buds were developing slowly, and the children experimented with ways of accelerating their growth. In one particular situation, it was discovered that twigs placed on an upper shelf responded faster than twigs at table level, which in turn responded faster than twigs in containers on the floor. The temperature difference from floor to top shelf turned out to be about 12° F.

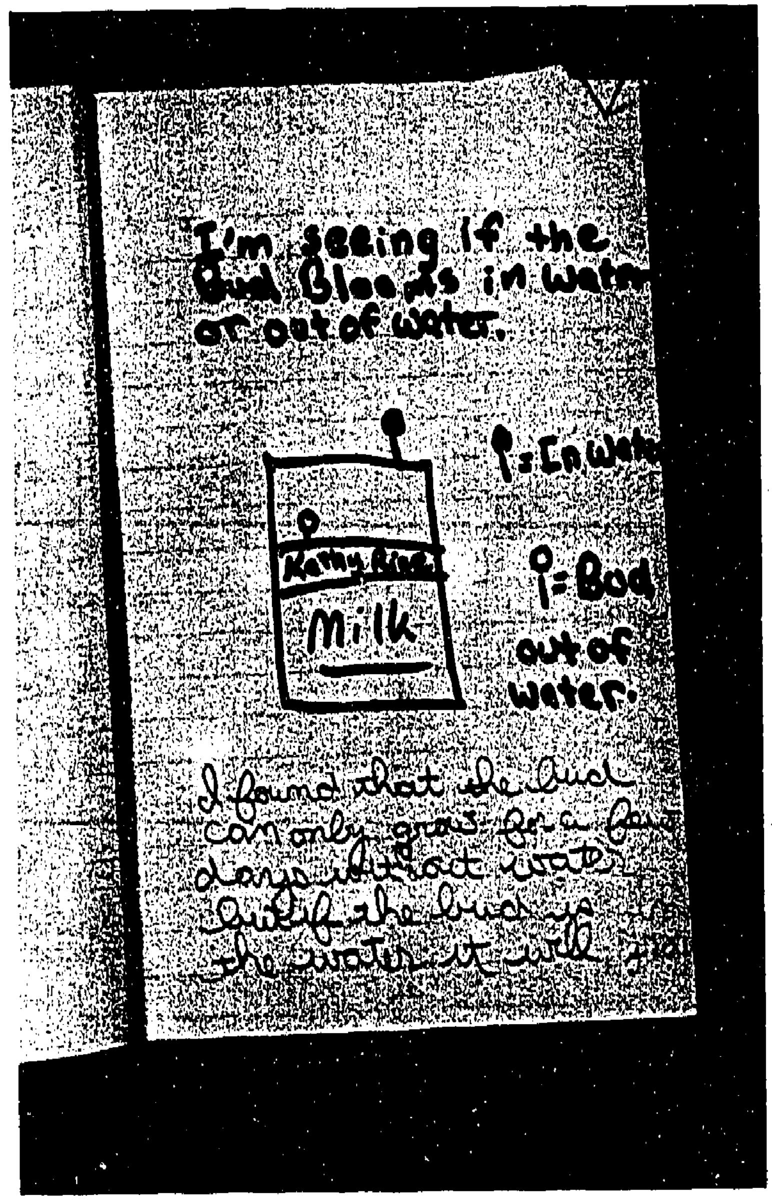
Often, the first experiments are not carefully conceived or executed. It is hard for children to understand that they should change only one factor in an experiment at a time if they are to find out what effect each factor has. They do not realize the necessity of using two twigs and comparing the altered twig to the unaltered one. You may be able to help your students become more aware of the need for experimental controls by suggesting that they compare their twigs with yours and with those of other children.

During the testing of the effect of temperature on the development of the buds in one classroom, a child pointed out that since some twigs bloomed faster no matter where they were placed in the classroom, there might be a natural factor within twigs that regulated the speed of their growth. They would, therefore, have to make sure to use twigs of the same *kind* of tree for their experiment. Others decided to take the twigs from the same *tree*. While doing this, they would choose twigs of similar thickness and number of buds and would make the cuttings of even lengths.

Another child testing the effect of light on growth placed one twig in a closed cupboard and taped another in its container on the outside of the cupboard door to keep the specimens as close together as possible, in an effort to control the variables that might affect development.

After the leaves had developed on his twig, one child noticed that only the end bud had developed and that the side buds had not. The children looked about for similar situations. Attention was drawn to three or four specimens in the classroom on which the end bud had been damaged by dissection. In all of these, vigorous growth was evident from the lower buds. One of the children suggested that the upper buds of other twigs be cut off to see what would happen.

The teacher supplied ailanthus and horse chestnut twigs which she knew had large end buds. In both of these species, when the end bud was removed, vigorous growth was observed from the lower buds. Those whose end buds remained intact showed little evidence of growth from the lower buds. Your class may find this striking behavior true of other species.



What will happen if the end is cut off after it has started to develop? Does all of the end bud need to be removed?

"Where Does the Water Go?"

Following the dissection of the internal structures of twigs, the question "What part of the stem carries the water up to the buds?" led one class to water-conduction experiments. Each child was allowed to use as many twigs as he wished and to test any part of the stem. Some stripped off all the bark; others gouged out as much of the soft, central pith as they could. One child cut a ring of bark from below every bud on her specimens. Despite the children's efforts, all these buds opened with equal vigor when the twigs were placed in water.

For experiments with water conduction, some teachers have made food coloring available, so that children could see the path of colored water through the twigs. One part of Sauer's blue food coloring in three parts of water makes a good dye.* One or two separate containers of the mixture have been used for the class collection of twigs. If you do this, you should make it clear to the children that the addition of the blue dye to the water simply makes it possible to see the system that transmits water and minerals through the plant. It does not *prove* that water and minerals are carried by that system. To prove that, children must find some method to *prevent* the dye from going up the stem.

Can you find some way to keep the dye from going up to the leaves?

The child who cut a strip of bark from below every bud on her specimen decided to repeat the experiment with the blue-dyed water. Once again the buds responded; this time, they were tinted a delicate blue. The loveliness of the blue-tinted leaves offset the girl's disappointment in "not having gotten the pipes." The third time she set up the experiment, she decided to cut deeper bands beneath only some of the buds, because, as she stated, "I want to get some more blue leaves too."

One boy sealed the end of his twig with petroleum jelly and cut holes in the bark above the water level in his container. When his results were discussed, the class objected as it became apparent that he had kept the dyed water out of all the layers, both from the end and the sides of the twig. He redesigned his experiment. This time,

* *Other food coloring has not worked as well. You can substitute any permanent ink.*

he carefully reamed out all the pith of a large ailanthus twig and was surprised to see that the blue dye still reached the buds.

Children commonly hold the theory that the pith is the water conductor in a tree. The pith, because of its softness and consistency, seems to them to resemble sponge. They think, therefore, that it must not only hold water but must also carry moisture to all parts of the tree. They also base this conclusion on the fact that pith can be found throughout the length of twigs of even very small diameter.

The rate of advance of the dyed water will be determined by the type of stem and the number of open leaves and blossoms. Eventually, the flowers and leaves will take on color. In one experiment, the bark was stripped down the full length of the twig, and it was possible to watch the blue edge of the dye advance up the stem. In an exceptionally bushy forsythia cutting, the blue edge advanced 20 inches in 10 minutes! Such an observation might encourage experimentation to determine the relationship of the amount of foliage to the rate of advance of the dye.

Does the number of leaves on a twig make a difference in the time it takes for the dye to reach them?

Can you take two twigs and devise a way to make the dye go through one into the other?

What would happen if you put the twig in the dye-water upside down?

This series of activities usually takes place well along in the unit. By this time, the trees and shrubs have started to bud out-of-doors, and your study of winter twigs is over. Some of the children may wish to observe the veins of leaves from different trees. Others may want to try dyeing annual plants or other growing things: "I have a carrot top growing at home. Can I put dye in that water?" Still others will enjoy dyeing twigs simply for their aesthetic value.

Insects and Twigs

During early investigations, when twig development is being forced, the heat of the room may occasionally hasten the hatching of insect eggs or awaken dormant larvae. In nature, this happens simultaneously with the emergence of the leaves and blossoms that the new generation of insects will eat. This interrelationship of plants and insects is awe-inspiring. Eight hundred species of insects are known to be dependent on the oaks alone. As the study of twigs continues, and as more fully developed branches are used, the unit may suddenly and dramatically become an insect unit. If this does occur, the children will become fascinated with the insects, and no amount of persuasion is likely to force them back to the study of twigs alone. The wisest decision is to bow to the new "lord of the room," for the tiniest crawling worm will command all the attention, and your pleas will go unheard.

Some insects will make their presence known over a weekend, and on Monday morning you will be faced with branches that are nearly stripped bare. In one classroom, this led to a fascinating study of the tent caterpillar. By replenishing the food supply with fresh branches each day, the class was able to watch the caterpillars enlarge their nest to incorporate the new materials. The children could easily see the caterpillars growing within the growing tent and were delighted to find the hidden entrance.

A simple cage of netting (an old marquisette curtain) was erected over the jar that held the branch and tent. Subsequently, the caterpillars spun cocoons, but the adults did not have time to emerge before the end of the school year. Since tent caterpillars are crop pests, the teacher disposed of them, rather than releasing them outdoors.

If leaf-chewing insects appear, have the class examine the twig for the crevice or egg sack from which the insect may have emerged. If you wish to continue the study, you will need to keep a supply of the particular leaves available and construct a simple cage.*

* *For further work along these lines, you may want to see the Elementary Science Study unit* BUTTERFLIES. *This is available from Webster Division, McGraw-Hill Book Company, Manchester Road, Manchester, Missouri 63011.*

Some Teaching Suggestions

Teacher's Role

You may find yourself teaching BUDDING TWIGS in a way that is new to you. Your role will be a supportive one: you will be the provider of materials, a referee during classroom discussions, a stimulator of further investigations—but not a dispenser of scientific facts or information.

Your children may be doing things they are not used to being allowed—let alone invited—to do. Some may need to be reassured that they are free to experiment with and dissect the twigs. Others—usually the children who have little faith in their own ability to make judgments—will ask and search for written material to give them the answers they feel are required. Usually this search for authoritative material subsides as the children become more confident of their own observations and after they have participated in a few class discussions based on observations.

After the initial introduction of twigs to dissect, the following general plan for classroom teaching seemed to evolve in trial classes. *By no means should this be interpreted as the prescribed course to follow.*

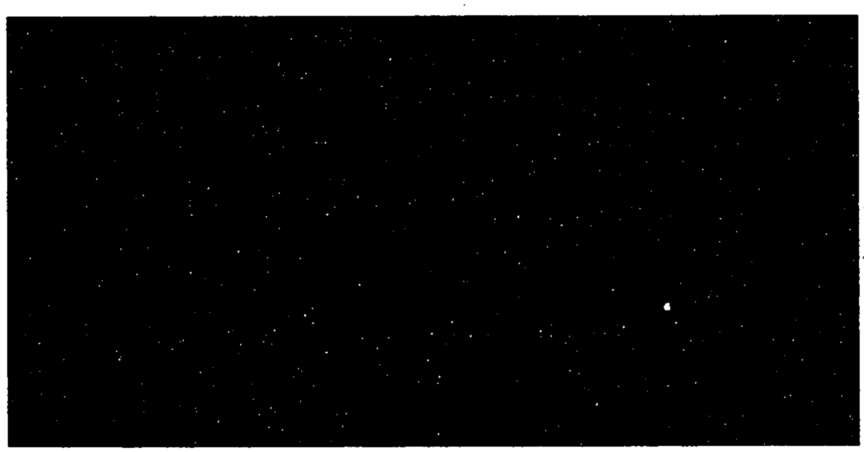
1. Discussion of changes or results of experiments.
2. Introduction of new twig or activity, inspection, dissection, and discussion.
3. Setting up further investigations.

It would be difficult to predict the time requirements of each phase. Dissection will monopolize some class meetings and will stimulate discussion and drawing. Of necessity, the activities will be dependent upon the growing things that are being studied. The changes in the twigs and the class's interest will provide you with clues as to which activities to encourage and which to drop.

Drawings

Drawing on the chalkboard is an important element in developing children's observational skills and inducing class discussion. At first, some of the children may be hesitant, feeling that they are expected to produce detailed drawings. This can be avoided if you yourself draw a rough sketch of a twig, showing the main stem with a bud, and ask for volunteers to add to the drawing. A series of these simple sketches across the board will allow a large number of children to be drawing simultaneously. Comparisons and corrections will be freely volunteered, and discussions will often arise.

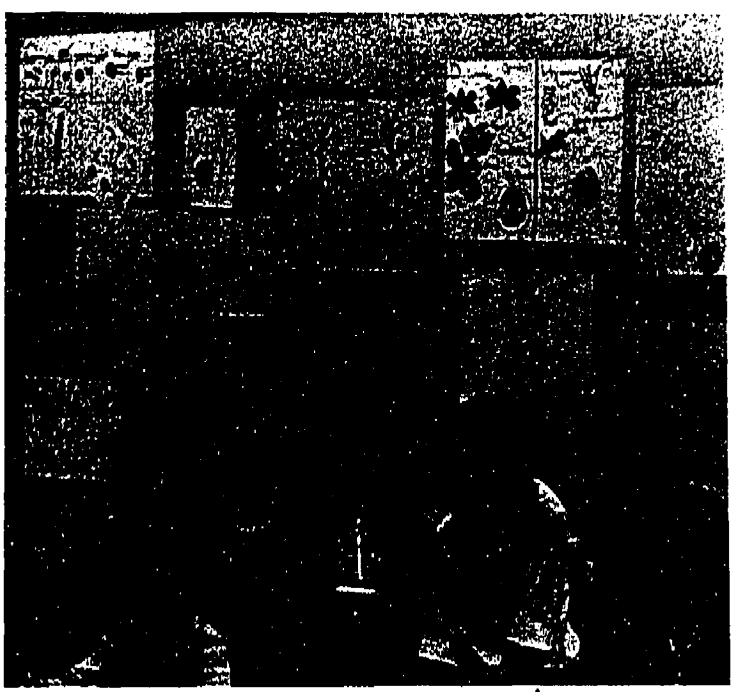
Children feel less intimidated if asked to add to a diagram than they might be if they were held responsible



for a complete drawing initially. If you invite "additions" (rather than "corrections"), the children are likely to respond and volunteer. Slowly, more exact representations of the twigs will emerge. As the unit progresses, amazingly precise and detailed drawings will be made by children who were reticent and unsure to begin with.

Periodically, the children can be given drawing paper on which to make larger drawings of their twigs. This activity, together with their drawings of twigs on the chalkboard, will give you an idea of the children's developing powers of observation and will promote classroom discussions based on conflicting observations. These drawings, together with mounted specimens, make attractive displays.

Identification of the trees and shrubs used is of minor importance to this study, although children and adults have a tendency to begin by asking "What is it?" Before the buds begin to develop, twig identification is difficult. As they develop, however, some structure – perhaps a leaf or a flower – will appear and give an additional clue, and individual children may wish to pursue identification on their own. In some classes, children have developed their own tree key guides, based on their own choice of observed characteristics, after they have examined many specimens.

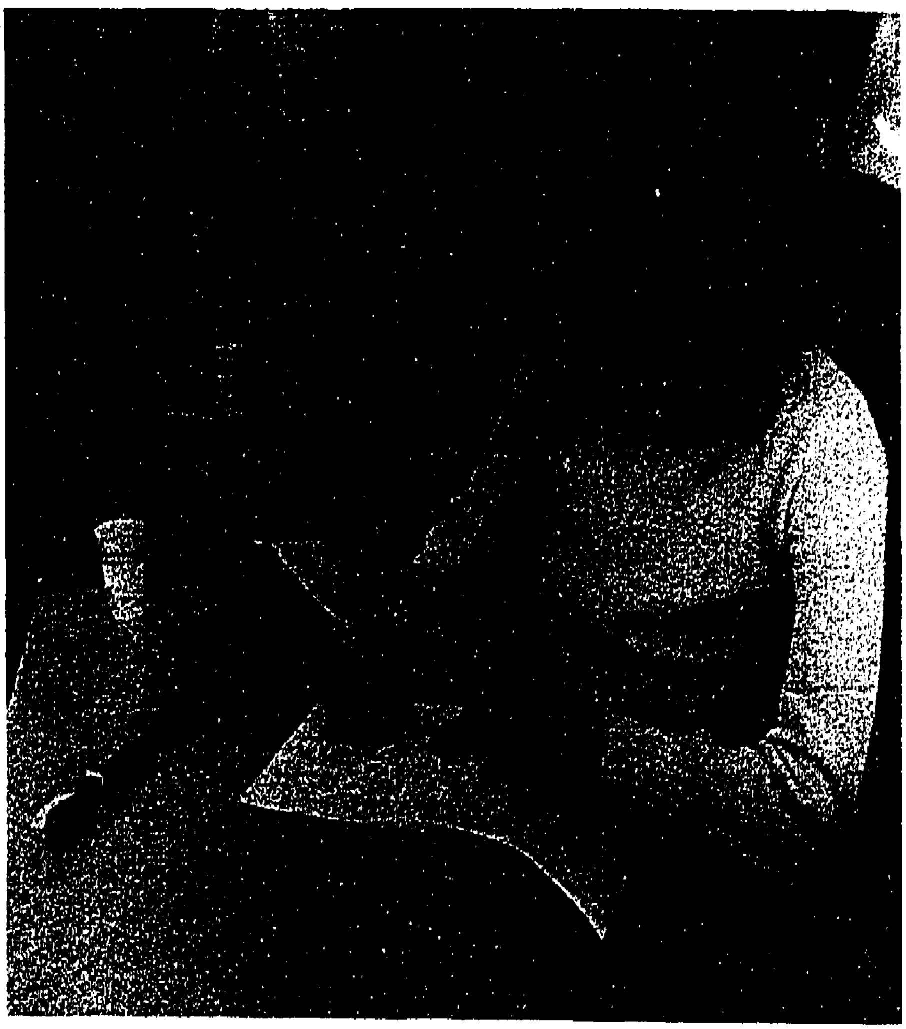


Notebooks and Records

Record-keeping is a natural and desirable aspect of any science unit. An interesting variety of approaches have been used by children in BUDDING TWIGS classes. No one format or formal outline has been presented or has seemed necessary. During the first class period, teachers have distributed inexpensive composition pads, with the suggestion that the class may find these useful for recording information. They have provided crayons for the children to make simple drawings of the twigs. Suggesting that the children make drawings seems to encourage less verbal youngsters to keep records and does not interfere with the keeping of detailed written records by other children. In trial classes, most students seemed to use a combination of drawings (in both pencil and colored crayons) and written statements. Another delightful way to keep records (and one that children thought up themselves) was to mount sections of the twig itself in the book. In many notebooks, the completely dissected buds were mounted under cellophane tape, attached with glue, or pressed on with modeling clay. Sometimes they were reassembled into their original form. Your children's initial mounts may only be badly torn sections of the dissected bud, but as more skill in dissection develops and encouragement is given, more carefully mounted specimens will appear.

Some children prefer to keep a running diary of the development of one tree and to assemble all data related to it.

A group of children who had access to school cameras did a pictorial study of the trees on their school grounds.



Terminology

Very early in the unit, you may find such terms as "chlorophyll," "cambium," and "leaf scars" appearing in some of the notebooks. Detailed diagrams of twigs and flowers copied from books will also appear. This should be neither encouraged nor discouraged. You can, however, ask the children to relate these words and drawings to the twigs in their containers. If you constantly and consistently refer the children to the twigs in the room, they will soon realize the importance you place on firsthand observation of the twigs. Later, you may wish to have the children carry out related reading research projects, but these should not be a substitute for direct experience with the materials.

When students realize that scientific terms are not expected and will not be imposed on them, a colorful working vocabulary is likely to emerge. (Throughout this *Guide*, the term "twig" is used as children have used it: to refer to any portion or section of a limb.)

Words identifying commonly known structures, such as leaves and bark, are generally used correctly by the children. They tend, however, to use the word "bud" synonymously with "blossom" or "flower." Leaf scars are called "hearts"; thorns become "needles"; and catkins are named "corncobs," "caterpillars," or "fuzzy worms." Later in the study, you may wish to introduce the correct terms for these structures casually, but do not insist that they be used, lest you prevent a child who has forgotten a term from participating freely in discussions.

It is better not to use scientific labels on the parts of flowers at this stage. Flowers of many trees are "imperfect," that is, one or more reproductive structures are missing. These flowers are highly specialized and difficult to understand. Often the male and female flowers are produced in separate buds, on separate branches, or even on separate trees. It is easy for children to become confused over the correct names for the parts.

In one classroom, the students had previously studied the classic diagram of a flower with its labels and used these terms inappropriately. Later, when catkins appeared, they were asked if these structures were flowers. In unison, they replied, "No! Flowers have petals." No amount of dissuasion could affect them. In other classes, on the other hand, the children automatically began referring to developing structures that were obviously not leaves as "flowers."

A Homemade Dissecting Scope

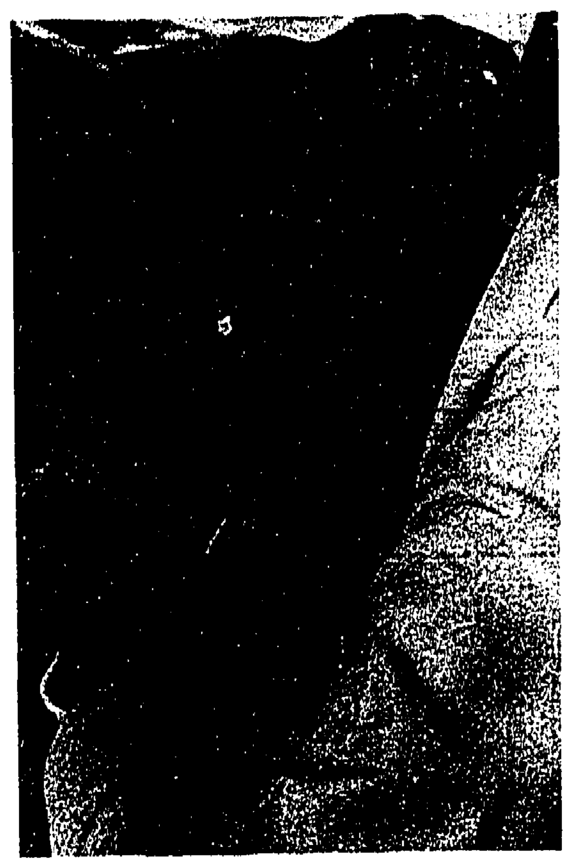
If your school owns dissecting magnifiers, the class may want to use them. If not, they can make their own. Some children prop the handle of a regular magnifying glass between a stack of books to free their hands while dissecting twigs.

An ounce (a walnut-sized lump) of Plasticine, a large pipe cleaner (the kind used for arts and crafts), and a hand lens are the components of a simple dissecting scope that children can make.

Here is how to make one:

1. Fold the pipe cleaner in half.
2. Place the handle of the lens into the fold of the pipe cleaner.
3. Wrap the pipe cleaner once or twice around the handle.
4. Twist the two strands of wire together.
5. Insert the other end into the lump of Plasticine.

The clay acts as a heavy base which sticks to the tray and prevents



the dissecting scopes from being upended. The double wire of the pipe cleaner holds the lens steady yet is easily bent to raise or lower the lens for better focus. This scope frees both hands for dissecting but still allows the child to hold the magnifying glass up to his eye on other occasions.

Children will need part of a period to assemble the scopes and at least the rest of the session to learn how to use them. They will need tweezers, T-pins (as probes), and a collection of expendable objects (seeds, pieces of cloth, cork, etc.) to experiment with. Each child should bring in a small box in which to keep his tools. The plastic wrapper can be kept over the lens to prevent scratching when it is stored in the box.

You may want to show children how to make dissecting scopes when they come to need them. Alternatively, you may want them to spend a period building their scopes before they begin to look at the twigs in class. Many classes have preferred to design their own scopes.

Making a Plant Press

As the unit progresses, and as more fully developed leaves and flowers are introduced, you can show the children how to make carefully pressed specimens. This will encourage some of them to start additional collections, which can be mounted on tagboard or the thin cardboard used by shirt laundries.

You can make a simple plant press, using two 12" x 18" pieces of heavy cardboard or 1/4" Masonite plywood. Cut newspaper sheets (23" x 30") along the fold line. Fold three of these half sheets in half and lay them as padding on one of the boards. Arrange your plants on one half of another sheet of newspaper, and fold the other half over it carefully. Put this folder on the board, and cover it with another pad made of three folded sheets of newspaper. Put another folder containing plants on top, and cover this with a pad of three folded sheets of paper. Do this until you have a stack several inches high.

Now, put the other board on top, and lay heavy weights on it—rocks, dictionaries, etc. Let the plants stay till the next day, and then change all of the newspapers, which will be damp from the moisture they have absorbed from the plants. The following day, just change the pads of newspaper between the folders of plants. Change the pads of newspaper every day or two until the plants are thoroughly dry. This may take a week or so.

Collecting and Caring for Twigs

What you do about getting twigs depends, in part, on how you choose to teach BUDDING TWIGS. If you approach it as an ecological study of a wooded area near your school, you and the children can collect the twigs together for use in the classroom. For many teachers, this has proved to be the most rewarding method of conducting the unit. Collecting trips allow the children to observe more closely the relationship of the twig to the complete plant system. They also provide fresh supplies of materials. This can benefit classroom results, and it eliminates storage problems. Finding their own twigs and sharing their finds with others can be very satisfying to children.

If you teach BUDDING TWIGS as an activity for a few children at a time, while others study different things, you may find it simpler to provide the twigs yourself. If you prefer this unit to be a whole-class activity, you can provide enough twigs for all the students to begin with and encourage them to bring in additional twigs.

Before starting the unit, you will have to select a suitable area to collect twigs in or to use for your outdoor study. A relatively open, level, dry field, devoid of thick underbrush, is ideal. (Avoid vine-entangled thickets and swamps, since you may encounter poison ivy or poison sumac.)

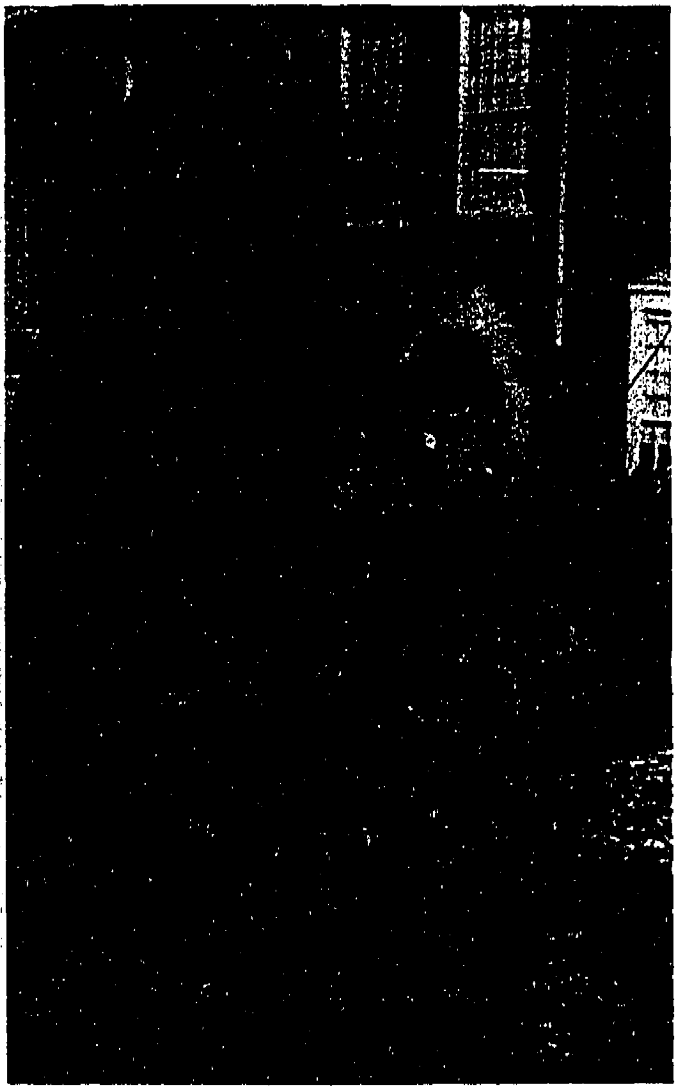
You can make a random selection of cuttings and force them at home to get some idea of the length of time the buds need to open. The heat of the room and the water will accelerate their development. Within any stand of trees, temperature and light variations cause buds to develop at different rates. This makes it possible to collect twigs at different stages of development in a small area. Make note of such variations for future needs when you are collecting.

All trees are protected by general trespass laws. Before collecting any twigs, you should have permission from the landowner, whether the land is held privately or by a public agency.

Cutting Suggestions

For general use, the students' specimens need not be longer than 18 inches. Longer ones will topple the milk cartons and may be a hazard to students' eyes. You will want one longer branch of each species, however, for a class collection. The children can compare the development of the class twig with that of their own. Remember, you will need a heavier and taller receptacle for the long twigs. A tall, plastic wastebasket, weighted to keep it from tipping over, should be adequate. To investigate through dissection the "age differences" among branches of a single tree, you will need a tree limb approximately eight feet long with its branches. You will also need three- to six-inch stem ends, but these you can cut from the twigs.

Cutting twigs and even branches, if it is done with reasonable care, will not harm a bush or tree and may, indeed, benefit it, as pruning does. Remove the most obviously ill-placed branches. Taking out crossed or badly overcrowded branches lets in more air and light. Try not to damage the trees accidentally while you are cutting. All cuts should be as clean as possible, leaving a smooth surface. If you cut a branch that is more than an inch across, you should paint the cut on the tree with tree-wound paint. (Some peo-



ple use ordinary paint spray to seal the cut and keep disease or insects out till it heals.)

Branches should never be torn from trees. When thin branches and twigs are removed, the cut should be made just beyond a side branch or bud from which future growth will develop. The cut should be a sloping one.

When removing limbs or heavier branches, you will need to be extra careful to prevent the bark and wood of the remaining portions from being torn when the severed portion falls. First make a small cut on the underside of the branch, and then saw down toward it. (Don't try to use pruning shears or wire cutters on large twigs or branches.)

Additional Sources of Twigs

Untold quantities of healthy branches are disposed of every year by professional and amateur tree pruners. Tree services are hired by electric power companies to trim branches from power lines. Home owners, professional gardeners, and municipal workers are also out pruning in early spring. Since these branches are usually disposed of, you can often get them just for the asking. Professional crews may, however, have wood-chipping machines with them, so you must act quickly to save the branches. In past experience, tree services have been very cooperative.

Other unexpected opportunities can come up. After a particularly severe storm, enough branches and twigs were collected from streets and backyards to supply two classrooms. When an addition to a school was being built, the children in that school got all the twigs they needed as land was cleared for the building. If teachers and children from other classrooms are told of your project, they can bring in cuttings, too.

Getting Advice

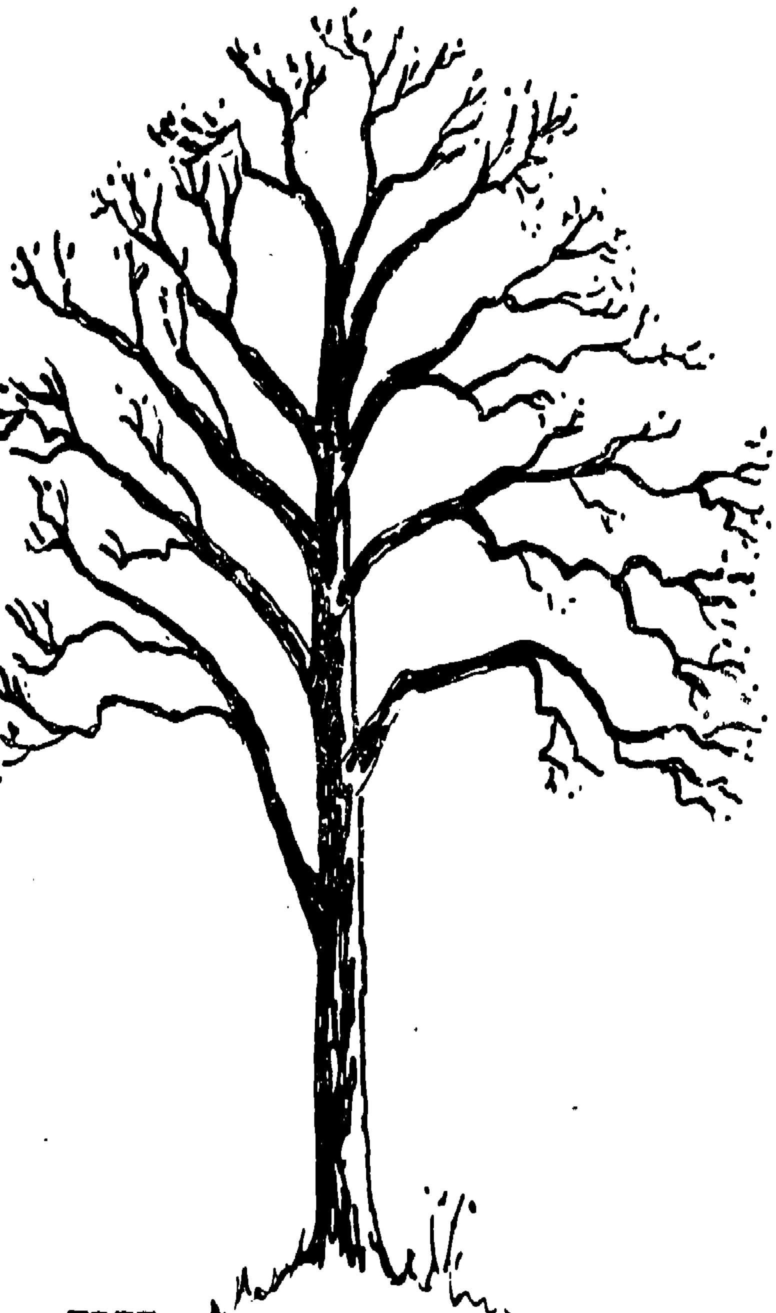
If you feel you need professional help in choosing twigs, it is surprisingly easy to find. You may wish to know when the trees in your locale will probably bud, which species will bud first, in what sequence the leaves or flowers will appear, which trees will have catkins, or where to collect specimens. All state, county, and municipal governments have a department of parks and forestry or a similar agency. Conservation commissions and private associations have members willing to assist you. Forest rangers do educational work as part of their regular assignments. (The prospect of a field trip led by a forest ranger is exciting to children.) Check with your state university's school of agriculture for additional assistance. It may have a field station in your area. Finally, most tree services and plant nurseries are generous with advice and, often, with specimens.

What to Look For

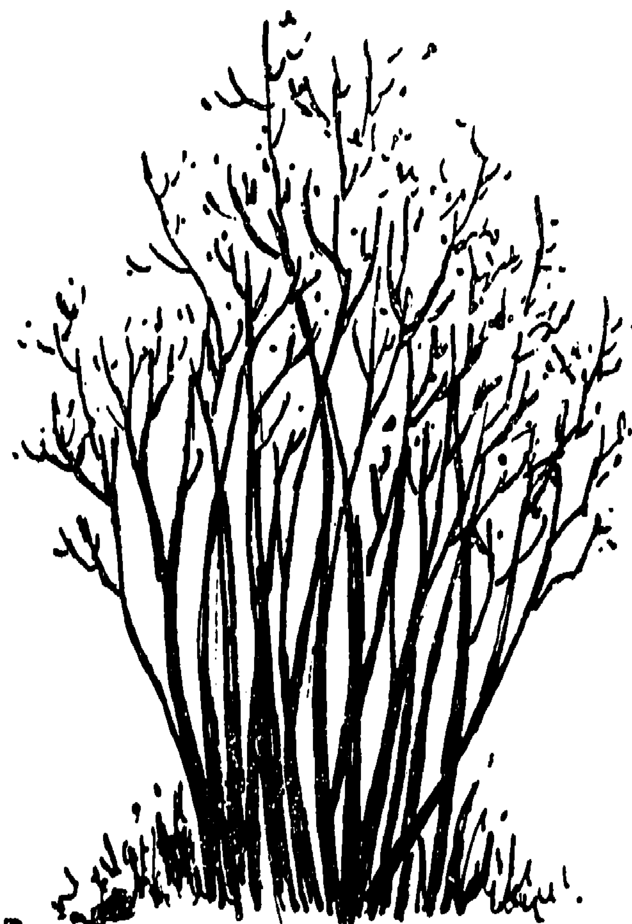
The drawings* that follow are included to give you some idea of the range of characteristics you can look for in selecting a variety of twigs. It is impossible to predict what specimens you will collect. You can, however, be fairly sure that a random collection will show enough variation in structure and growth patterns to be useful for this study.

* *The drawings on pages 33 to 37 may be reproduced for use by students and teachers.*

Your cuttings may come from a–

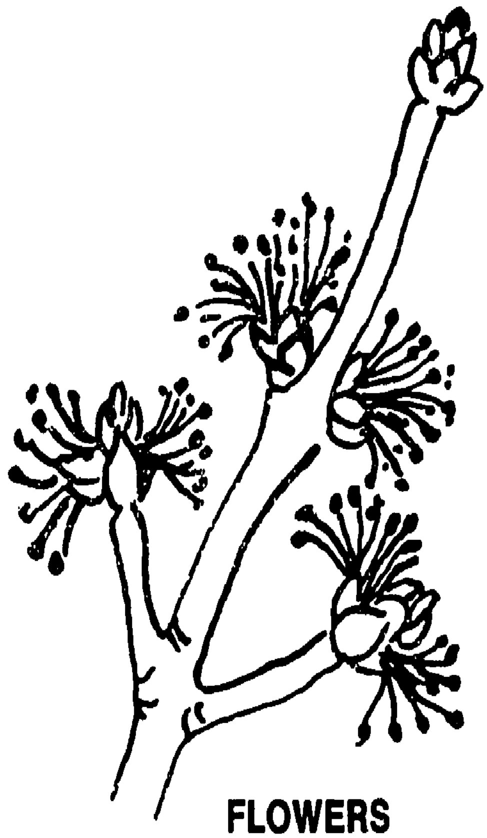


TREE



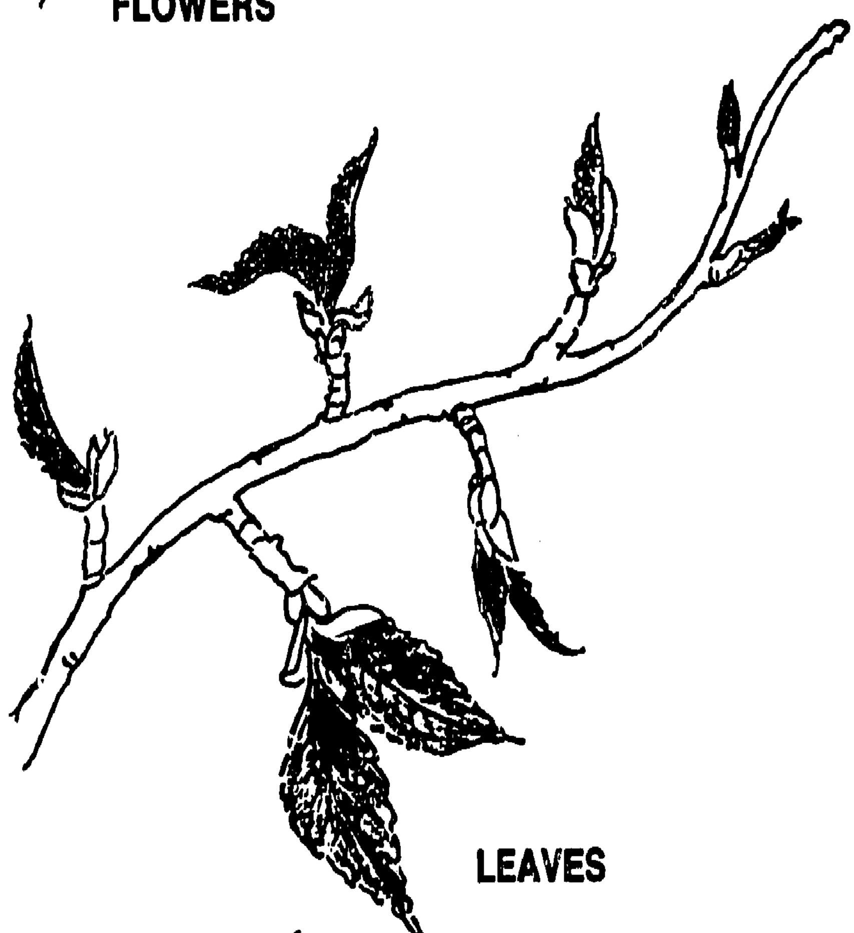
SHRUB

Your twigs may include--



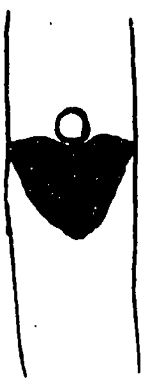
FLOWERS

BUDS

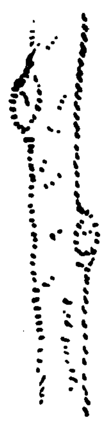


LEAVES

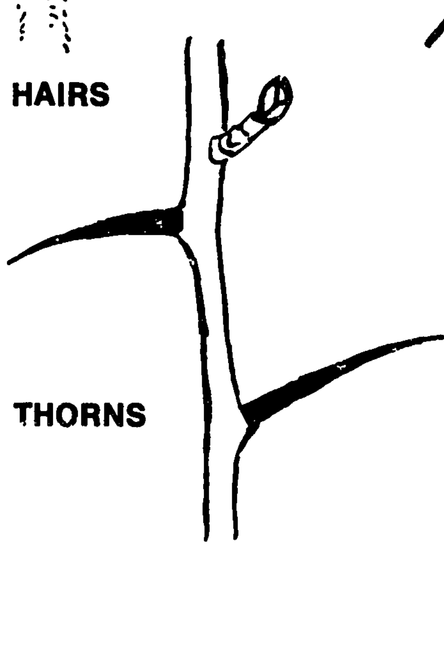
A cutting may have—



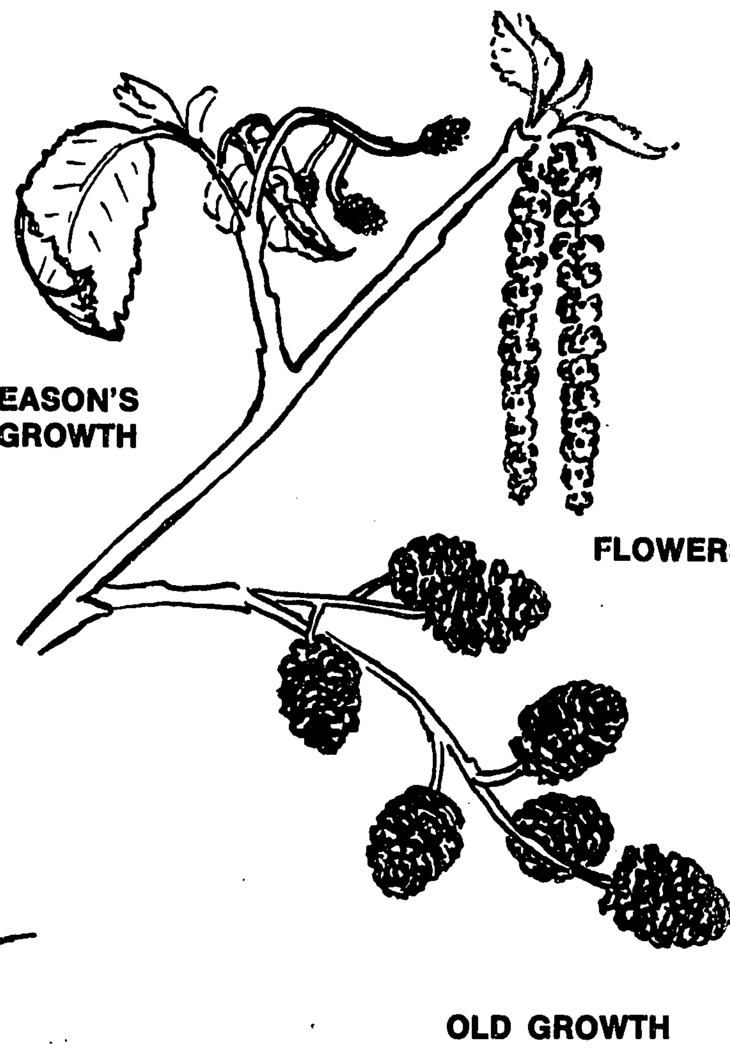
LEAF SCARS



HAIRS



THORNS



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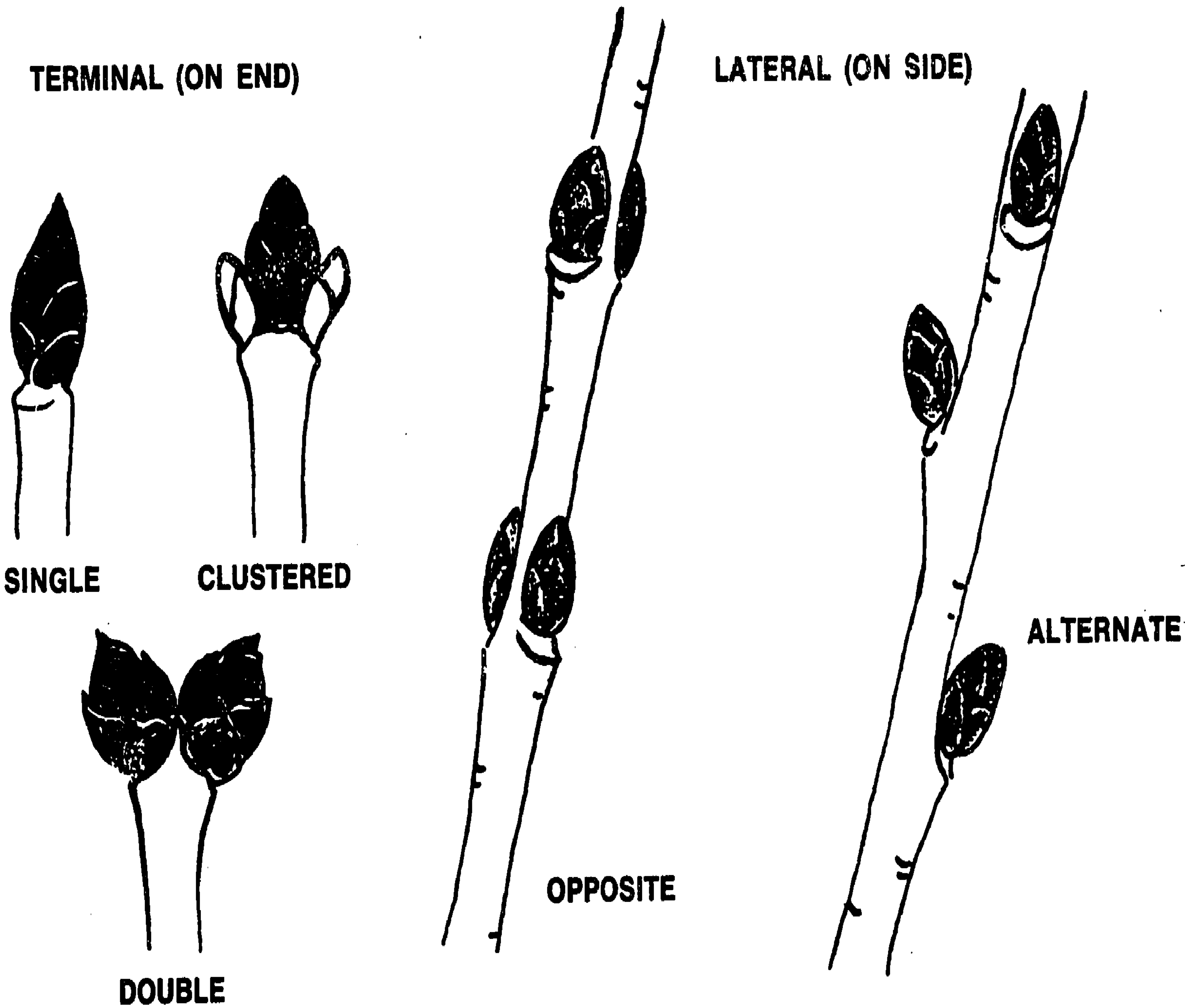
Buds may be –

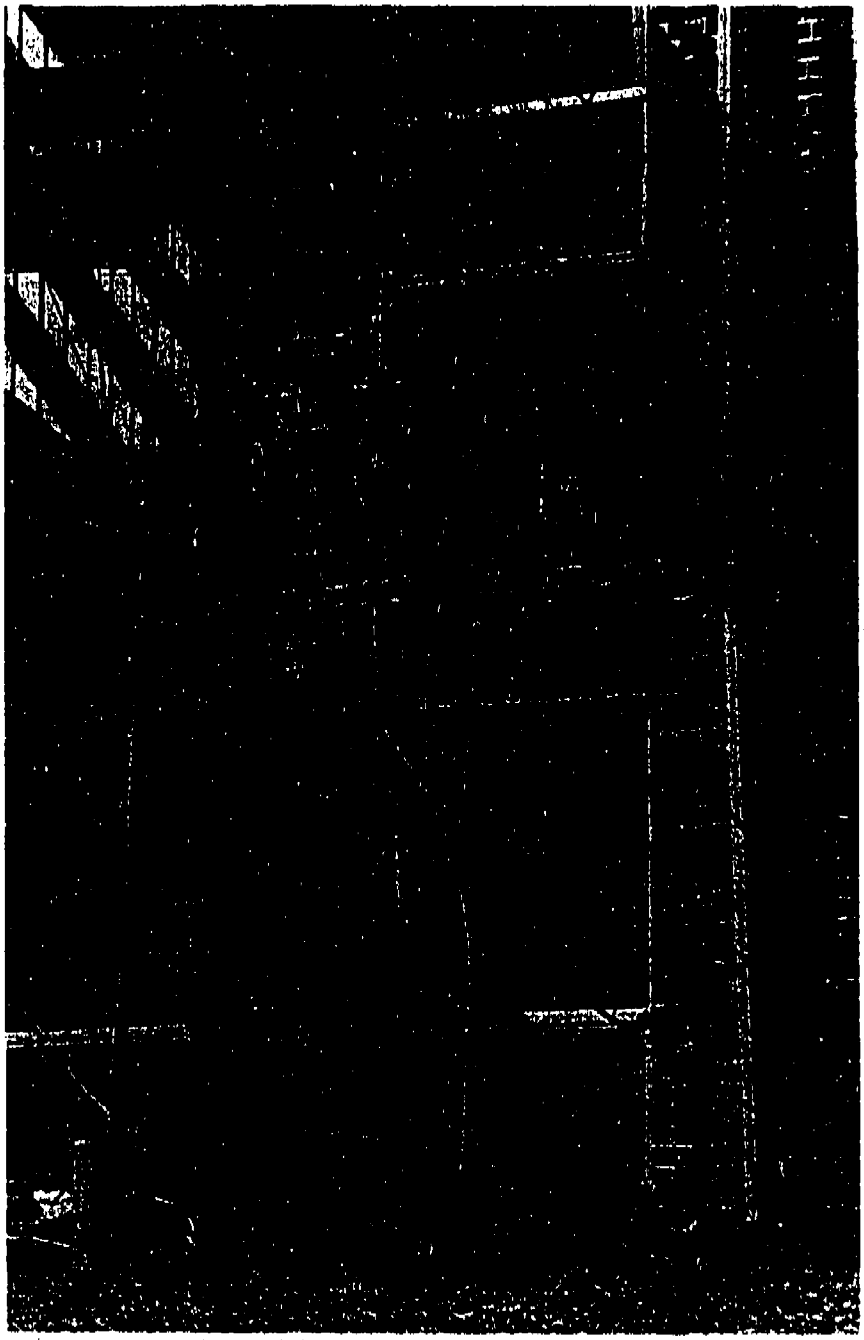

TERMINAL (ON END)
SINGLE
CLUSTERED
DOUBLE
LATERAL (ON SIDE)
OPPOSITE
ALTERNATE

Storing Specimens

If you are going to collect many specimens at a time, you will need to prevent their drying out or blooming before you are ready for them. This means they must be kept moist and cold but not be allowed to freeze.

To keep the twigs from drying out, make manageable bundles (three to four inches in diameter), and fasten wet paper toweling around the cut ends with rubber bands. Put the whole bundle into a large plastic bag, close the end tightly with a twist tie, and store the bag in a cold place. Twigs held under refrigeration at 33° have remained viable from February 23 until June 1. If you have a refrigerator in the school, you may be able to use it to store twigs. It is simpler to use one with its shelves removed, provided the door can be locked for the safety of the children. If you do not have access to a refrigerator, you can keep cut twigs alive outdoors in winter, but they must be well wrapped to prevent their freezing or drying out and dying.

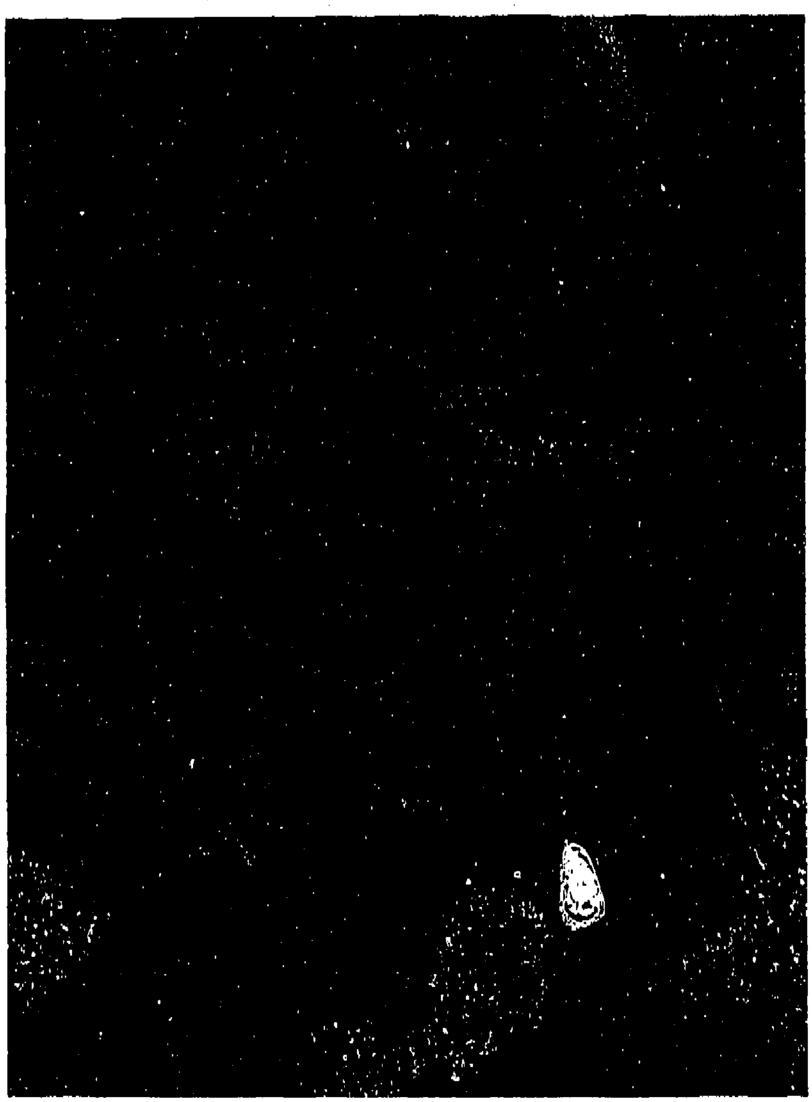
A twelve-foot limb with all its branches was kept alive outside successfully by one teacher. It was held upright in a large wastebasket filled with sand and remained from February through winter snows and temperature changes until it bloomed in the spring. This may prove to be the simplest method for collecting and keeping materials. Twigs can then be cut off the large limb and brought in to be forced at will. The remaining limb can be sawed into a tree puzzle (see page 13).



Caring for Twigs in the Classroom

The most frequent source of trouble in working with twigs has been unpredictable temperature variation in classrooms. In schools where temperatures drop considerably during the night and over weekends, buds have been slow in developing. A partial remedy has been to move twigs away from the windows into warmer areas of the room at the end of the school day. In rooms where heat is excessive, leaves and flowers have become dehydrated quickly and have fallen off. If you have a water-mist sprayer (the kind that florists use) or an old liquid spray bottle, it may help to spray the buds periodically.

Water levels in the containers should also be kept high, since the twigs absorb considerable amounts. The water should be changed weekly to reduce the possibility of mold developing around the twig ends. As twigs die—and some do for a variety of reasons—they should be discarded.



Reference Material

Most children's books about trees show the mature leaf as the main means of identification. Since this unit begins with "bare" winter twigs, such books are of little value when children first feel the need to identify their specimens. Most of the adult tree-key guides are too difficult for the average child to use, with the exception of the two Symonds and Chelminski volumes mentioned below. These are expensive books but valuable to have in a school library, because they are so easy for children to use.

Guides to local trees and shrubs are available from your state department of agriculture or forestry and are of interest to children. These are available to schools free or at minimal cost. They are often excellent sources of information about conservation and forestry.

The following list of books may be helpful to you if you feel the need to be able to identify your specimens for collecting purposes.

Baerg, Harry, *How to Know the Western Trees*, Dubuque, Iowa, Wm. C. Brown Company Publishers, 1955.

Berry, James B., *Western Forest Trees*, New York, Dover Publications, Inc., 1964.

Grimm, William C., *The Book of Trees*, Harrisburg, Pennsylvania, Stackpole Books, 1962.

_____, *Recognizing Native Shrubs*, Harrisburg, Pennsylvania, Stackpole Books, 1966.

Harlow, William M., *Fruit Key and Twig Key*, New York, Dover Publications, Inc., 1946.

_____, *Trees of the Eastern and Central United States and Canada*, New York, Dover Publications, Inc., 1942.

Jaques, Harry E., *How to Know the Trees*, Dubuque, Iowa, Wm. C. Brown Company Publishers, 1946.

Montgomery, F. H., *Native Wild Plants of Northeastern United States and Canada*, New York, Frederick Warne & Co., Inc., n.d.

Petrides, George A., *A Field Guide to the Trees and Shrubs*, Boston, Houghton Mifflin Company, 1958.

Rogers, Walter E., *Tree Flowers in Forest, Park and Street*, New York, Dover Publications, Inc., 1935.

Symonds, George W. D., and Chelminski, Stephen V., *The Tree Identification Book*, M. Barrows & Company, Inc., New York, 1958.

Symonds, George W. D., and Merwin, A.W., *The Shrub Identification Book*, New York, M. Barrows & Company, Inc., 1963.

White, J. H., *The Forest Trees of Ontario*, Toronto, Queen's Printer, n.d.

Zim, Herbert S., and Martin, Alexander C., *Trees*, Golden Nature Guide, New York, Golden Press, 1952.

In addition, children find the following film loop enjoyable:

Harlow, William M., *The Magic of Tree Buds*. This 4-1/2 minute, color loop was issued in 1967 by Ward's Natural Science Establishment, Inc., Rochester, New York.

Budding Sequence Chart

Note: The following chart is not meant to be complete. You may want to make your own chart or add to this one.

Family & Common Name	Time of Bloom	Blossoms Appear
Ailanthus		
ailanthus	June	when leaves full-grown
Birch		
smooth alder	March, April	before leaves
hoary alder	March, April	before leaves
beaked hazelnut	April, May	before leaves
American hazel	March, April	before leaves
hornbeam	April	after leaves
hop hornbeam	April, May	with leaves
yellow birch	April	before leaves
white birch	April	before leaves
sweet brich	April	before leaves
red birch	March, April	before leaves
paper birch	April	before leaves
Buckthorn		
common buckthorn	May	with leaves
Indian cherry	May, June	when leaves half-grown
Crowfoot		
shrub yellowroot	April, May	before or with leaves
Custard Apple		
pawpaw	April	with leaves
Dogwood		
tupelo	May, June	when leaves half-grown
Ebony		
persimmon	May, June	when leaves half-grown
Elm		
winged elm	March	before leaves
white elm	March, April	before leaves
slippery elm	March, April	before leaves
hackberry	May	after leaves
cork elm	March, April	before leaves
Heath		
pink azalea	April, May	before or with leaves
Holly		
mountain holly	June	when leaves more than half-grown
Laurel		
Benjamin-bush	March, April	before leaves
sassafras	May	with leaves
Maple		
Norway maple	May	before or with leaves
sugar maple	May	with leaves
striped maple	May	when leaves nearly grown
silver maple	March, April	before leaves
red maple	March, April	before leaves
mountain maple	June	after leaves
box elder	April	before leaves
Mezereum		
moosewood	April	before leaves
mezeron	April	before leaves

Family & Common Name	Time of Bloom	Blossoms Appear
Mulberry		
red mulberry	May, June	blossom with leaves
Osage orange	June	after leaves
Oak		
white oak	May	when leaves one-third grown
willow oak	May	when leaves small
yellow oak	May	when leaves one-third grown
Spanish oak	May	blossom with leaves
swamp white oak	May	when leaves half-grown
scarlet oak	May	when leaves half-grown
shingle oak	May	when leaves half-grown
red oak	May	when leaves half-grown
post oak	May	when leaves one-third grown
pin oak	May	when leaves half-grown
chestnut oak	May	when leaves one-third grown
bur oak	May	when leaves one-third grown
black oak	May	when leaves half-grown
blackjack	May	when leaves half-grown
bear	May	when leaves half-grown
Olive		
black ash	May	before leaves
blue ash	April	before leaves
fringe tree	May, June	when leaves one-third grown
green ash (variety of red ash)	May	with leaves
red ash	May	with leaves
white ash	May	before leaves
Pea		
redbud	April, May	before or with leaves
locust	May	after leaves
Kentucky coffee tree	June	after leaves
honey locust	May, June	after leaves
Pine		
tamarack	May	with leaves
Plane Tree		
sycamore	May	with leaves
Plum		
beach plum	April, May	before leaves
dwarf cherry	April, May	with leaves
Rose		
white thorn	May	when leaves nearly grown
wild red cherry	May	when leaves half-grown
scarlet haw	May	when leaves half-grown
mountain ash	May, June	after leaves
juneberry	April	when leaves one-third grown
dotted haw	May, June	after leaves
crab apple	May, June	when leaves nearly grown
cockspur thorn	May, June	after leaves
choke cherry	May	after leaves
Canada plum	May	before leaves
black cherry	May, June	when leaves half-grown
Rue		
prickly ash	April, May	before or with leaves
Storax		
silver-bell tree	May	when leaves one-third grown

Family & Common Name	Time of Bloom	Blossoms Appear
Sumac		
fragrant sumac	March, April	before leaves
Walnut		
hickory	May, June	when leaves half-grown
black walnut	May	when leaves half-grown
butternut	May	when leaves half-grown
mockernut	May	when leaves half-grown
pignut	May, June	when leaves half-grown
shellbark hickory	May	after leaves
Willow		
Lombardy poplar	April, May	before leaves
balsam	March, April	before leaves
black willow	March, April	before leaves
cottonwood	March, April	before leaves
shining willow	April	before leaves
Witch Hazel		
sweet gum	March to May	when leaves half-grown